

**TUBERCULOSIS OF
BONE AND JOINT**

OXFORD UNIVERSITY PRESS
AMEN HOUSE, E C 4
LONDON EDENBURGH GLASGOW NEW YORK
TORONTO MELBOURNE CAPE TOWN BOMBAY
CALCUTTA MADRAS
HUMPHREY MILFORD
PUBLISHER TO THE UNIVERSITY

OXFORD MEDICAL PUBLICATIONS

TUBERCULOSIS OF BONE AND JOINT

BY

G. R. GIRDLESTONE

MA, BM OXON, FRCS ENG

NUFFIELD PROFESSOR OF ORTHOPAEDIC SURGERY

FELLOW OF NEW COLLEGE OXFORD

HON SURGEON AND HON CLINICAL DIRECTOR

WINGFIELD MORRIS ORTHOPAEDIC HOSPITAL

OXFORD

OXFORD UNIVERSITY PRESS
LONDON: HUMPHREY MILFORD

1940

TO
VISCOUNT NUFFIELD
BENEFACTOR OF ORTHOPAEDIC SURGERY
IN OXFORD
THROUGHOUT GREAT BRITAIN
AND IN THE DOMINIÖNS
THIS BOOK IS MOST GRATEFULLY
DEDICATED

PREFACE

THIS book with all its imperfections comes at least from a background of great interest and much experience, for its author after a fortunate and happy apprenticeship with Robert Jones and Sister Hunt, has spent twenty years at this work learning from success, from failure, and from his specialist colleagues in England and all over the world. Furthermore he owes not a little to his junior colleagues, the past and present staff of his own hospital, whose running criticism provides a bracing atmosphere in which authority withers and only true principles and reasonable practice can survive. From this practical training he has derived some understanding of the invading infection and human resistance, and some ability to find the best solution of each one of the infinite variety of individual problems. Surely the avoidance of rule and routine is the foundation of good treatment: a patient will be treated indifferently who is treated impersonally on standard lines. In skeletal tuberculosis many factors contribute to each clinical picture: we must group the cases for systematic teaching, but they are better regarded as individual problems in the wards, therefore we plan our treatment to suit the case and alter the plan if the indications change: learning to wait for and recognize the right time for each new step.

I have tried to present clearly and with significance a balanced conception of the disease, with the bearing and time relations of infection and reaction, and to describe the various influences at work, favourable or the reverse, and how far and in what way they can be controlled. A complete grasp of all this is fundamental, but not nearly all that is demanded of us. When for example, in the course of the morbid process, joints are damaged or deformed the patient needs a combination of biologist, engineer, and surgical craftsman. Such indeed are the acquirements of every orthopaedic surgeon worth his salt, and he will serve best who has attained the fullest understanding and skill. Stimulated by Sir Arthur Keith,¹ he will have studied the characteristic reactions of osteocyte and fibrocyte so that he may foresee and bend to his purpose the living response of the materials of his craft.

G R GIRDLESTONE

OXFORD
January 1940

¹ *Menders of the Maimed*, Oxford Medical Publications, 1919

ACKNOWLEDGEMENTS

THE Author wishes to acknowledge most gratefully the help of many friends including his colleagues Messrs W B Foley, J C Scott, and L W Plewes, also the loan of radiographs by

Dame Agnes Hunt, Figs 81*a* and 81*b*

Mr Norman Capener, Figs 15 and 16

Dr H Waldenström, Figs 17, 18, 53*a*, and 53*b*

Mr W T G Pugh (by permission of the London County Council),
Figs 33, 159, 160 and 161

Mr H J Seddon, Figs 58 and 59

Mr Hugh Trumble (Melbourne), Figs 44, 45, and 46

Mr G R du Toit, Figs 125, 132*a* and 132*b*

Mr E S Evans, Figs 143*a* and 143*b*

Mr R Weeden Butler, Figs 153 and 154

and of blocks by

Messrs John Wright & Co (*British Journal of Surgery*)

Messrs Harrisons, Ltd

The Oxford University Press,

The British Medical Journal

He would like to add special thanks to Mr J C Scott, for the tables of end-results which represent an enormous amount of work, to Miss Joan Dudley Corbett, M S R, for her unsparing and most skilful help in the selection of radiographs and the preparation of the prints, and to Mr G T Hollis of the Oxford University Press, who by his most patient courtesy has made the task of authorship possible—almost pleasant

CONTENTS

PREFACE	VII
ACKNOWLEDGEMENTS	IX
I GENERAL CONSIDERATIONS	1
The Nature of the Disease	1
Prophylaxis	2
The Skeletal Lesion	3
Medico legal	4
Site of Infection	5
Complications	7
II DIAGNOSIS	9
Clinical Examination	9
Provisional Diagnosis	11
III THE GENERAL TREATMENT OF THE DISEASE	15
Diet	15
The Action of Sun and Wind	15
The Effects of Prolonged Decubitus	17
IV THE LOCAL TREATMENT OF THE DISEASE	20
V OPERATIVE TREATMENT	24
Cold Abscess	24
The Prevention and Treatment of Secondary Infection	25
The Elimination or Healing of the Skeletal Focus	26
For the Correction of Deformity	29
VI THE HIP	31
Pathology	31
Diagnosis	33
Treatment	54
Operations	70
VII THE SPINE (POTT'S DISEASE)	96
Pathology	96
Diagnosis	102
Treatment	125
VIII THE KNEE	144
Pathology	144
Diagnosis	146
Treatment	157
Results	166
Summary	169

I\ SACRO ILIAC JOINT	171
\ ANKLE	182
XI TARSUS	187
XII METATARSUS AND PHALANGES	191
XIII SHOULDER	193
XIV ELBOW	205
\ WRIST	213
XVI METACARPUS AND PHALANGES	221
XVII POTT'S PARAPLEGIA	223
The Causes of Paraplegia	226
The March of Symptoms and Signs	226
Prognosis	231
Diagnosis	233
Treatment	235
The End results and their Lesson	249
APPENDIX	
The Robert Jones Frames	251
How to make a Plaster Bed and a Turning Case	252
The Carshalton Frame	253
Some Statistics of Tuberculosis of the Knee at the Shropshire Orthopaedic Hospital	257
Some Statistics of Tuberculosis of the Shoulder at the Shropshire Orthopaedic Hospital	259
Occupational Therapy Vocational Training Re-conditioning and Rehabilitation	260
Lovett's and Kingsley's Tables	262
INDEX	263

CHAPTER I

GENERAL CONSIDERATIONS

THE NATURE OF THE DISEASE

TUBERCULOSIS of a bone or joint is a metastatic focus and a proof of disease elsewhere which is active enough to give rise to bacillaemia. In children it almost always comes from long standing infection of the lymphatic glands, and this lymphatic infection, though often unsuspected, is the root of the disease, forming a lesion inaccessible, insidious, and in issue more dangerous than that of the bone or joint. This lymphatic tuberculosis is of a rather different nature to that of a bone or joint, for the disease is taking place within a filtration system. Lymph glands are filters in which tubercle bacilli are caught on their way from the alimentary tract to the blood. A healthy gland is an effective filter, it protects the blood from the casual invader, but a gland rotten with disease is much worse than a bad filter, for it has become a breeding ground, swarming with bacilli, established within the defences of the body, and drained by channels leading directly to the blood stream. This glandular disease was established long before its more disabling and evident metastasis brought the patient to diagnosis and treatment. The original disease had got a hold because the patient's resistance was low as the bacillary infiltration advanced he became less and less able to arrest it.

These hidden foci are easily forgotten, yet they must be kept in mind, often long after the arrest and apparent cure of the local disease. Only thus can final healing be achieved.

Man often fails to arrest tuberculosis decisively, leaving a process so slow and insidious that the infection resembles a symbiosis. But the resemblance is false! This is no true symbiosis but a destructive and deadly disease, giving rise to a slow succession of metastatic foci, each one an added source of toxæmia and distress. It is almost always our fault if this happens in children, perhaps more often than not in adults too. Indeed, our patients should be given to understand that permanent healing is to be expected provided that treatment and after care are efficient and adequately prolonged, but that there is no possible short cut. To this statement there are, of course, a few exceptions. These will be discussed later.

The rival powers of man and the tubercle bacillus are delicately balanced. The virulence of the bacillus may be regarded as constant,¹ but man is a variable factor, resistant or susceptible. Only too often poor health temporarily lowers his natural resistance and he becomes susceptible to the disease until vigour and vitality have been restored.

Children are wonderfully responsive to treatment, if a bone or joint lesion keeps them in an open air hospital for a year or two it is probable that the

¹ Griffith A. S., *J. Path. and Bact.*, 1916 xx.

lymphatic tuberculosis will be healing or healed. Unfortunately, this is not so with adults, first, because the bone lesion is generally a late result of an extensive, chronic, and slowly advancing disease of deep seated lymph glands, and, secondly, because they are much less responsive to the stimulation of the wind and the sun. They do respond up to a point, becoming well and strong whilst in an open air hospital, but very good after care is needed to maintain that health after they go home, and even this will fail if they go too soon. Similar causes produce similar results. A long standing, deep seated tuberculous infection, active and bacillæmic under his old working and home conditions, produced the focus for which the patient came into hospital. If he goes back to the *same home conditions with the lymphatic infection unhealed*, it is only reasonable that he should relapse, for his vitality will return to its old level and his newly acquired resistance will be lost.

This is, unfortunately, quite a common story. We have in connexion with the Wingfield Morris Orthopaedic Hospital an organization of follow up and after care designed to eliminate, or at least to minimize, this risk. Nevertheless, in a recently investigated series of 300 patients who had been out of hospital for five years or more, 15 cases had returned to hospital with new bone or joint lesions, other tuberculous lesions, or died. Without a thorough system of follow up, a 'cure' in one hospital register is often a very sick patient in another hospital, a misnomer disastrous for the patient and his leading for the surgeon. Statistics are worthless unless they concern *true end results*, ascertained, let us say, at least five years after the patient's discharge from hospital.

1. Bovine

(a) *Through milk*. Tuberculous milk is responsible for the great majority of cases of bone and joint tuberculosis in young children. This source of infection can be cut out by eliminating bovine tuberculosis or by pasteurization of the milk. The principal towns of Canada and the United States of America have, by enforced pasteurization, reduced bone and joint tuberculosis in young children by as much as 75 per cent, and the experience there is that most of the young children with tuberculosis come from country districts where *raw milk is still drunk*.

(b) Rarely by direct *implantation*, e.g. in butchers.

2 Human, by *ingestion* or *inspiration*, very rarely by *implantation*

PROPHYLAXIS

This may be summarized as follows

1 Raising the level of health of the community. This is to be achieved by many means, such as the elimination of overcrowding, of unhealthy housing, of poverty, of ignorance as to diet, of overwork, and of work under bad conditions.

2 Elimination of the sources of infection, human and bovine.

All this is social service, a duty of governments and of local authorities. It concerns tuberculosis of every sort, is immensely important, but outside the scope of this book.

THE SKELETAL LESION

Tubercle bacilli are carried to the spot by the blood, probably with the debris of breaking down lymph glands. In children, the occurrence of various embolic lesions close to the joints or epiphyseal disks, whether tuberculous, pyogenic, or due to uninfected infarction, is relatively common. This is due to lack of arterial anastomosis in these regions, where small areas of bone lie beside, or are surrounded by, avascular cartilage, for the embolism of an end artery leads to ischaemia or complete infarction (Figs 15 and 16, p. 44), and, when the embolus carries organisms, the infarction favours the infection. Local resistance can be reduced by a bruise.

Devitalization, general or local, and a massive deposit or shower of bacilli are factors predisposing to the development of a local lesion. Once they have obtained a foothold their continued advance is favoured by poor vitality of the patient, and by any strain or movement imposed upon the infected parts by lack of immobilization. The bacilli multiply and, so far as the cells surrounding them are killed, there are produced areas of necrosis and caseation. At the periphery infiltration goes on until constructive reaction limits the advance. Besides this direct spread of disease, a collection of debris, or abscess, may discharge its contents along the path of least resistance.

On the other hand, a characteristic initial reaction of the tissues to the presence of tubercle bacilli is occurring. The bacilli are surrounded by endothelial cells and lymphocytes, and with commonly a few giant cells forming a striking feature of the histology. The seclusion of the bacilli depends upon each focus being completely surrounded by a wall of living cells capable of survival. During the initial stages there are gaps in the defence and bacilli spread along lymph spaces and are carried along lymphatics to the regional glands. But before long the foci are completely surrounded by cellular infiltration, and if all goes well the resistance of the patient rises and the cells infiltrating the neighbourhood of the lesion, now capable of surviving the local toxæmia, succeed in building up a sound fibrous capsule round the dead or dying bacilli. By this process they accomplish the arrest of the lesion. In the course of time the fibrosis hardens and the healing becomes sound, ultimately calcification may take place. The process of healing calls for the constructive activity of granulation tissue in which fibroblasts have replaced the original reactionary fighting cells and formed a wall of scar tissue, whether fibrous, calcified, or osseous. Inside this wall are the agents and products of destruction, outside it are normal cells carrying out their ordinary functions, whether synovial, cartilaginous, or osseous. Furthermore, we say that the healing is 'sound' when the wall is solidly composed of adult cell elements. The constructional units, fibres, or bone plates no longer show a disorderly arrangement or any infiltration with young

unsettled cells, but are now purposefully arranged to fulfil their permanent function of resisting safely any forces to which they are likely to be subjected by the active use of the limb

Only the full understanding of the histology of healing gives the surgeon a well balanced clinical judgement in treatment and prognosis. Thus it can be seen that when a diarthrodial joint is infected with tuberculosis it is not safely and permanently cured unless it either moves freely or is soundly ankylosed. In children one may hope for a freely movable joint as the result of early, effective and long continued conservative treatment. But in adults conservative treatment of weight bearing joints hardly ever leads to sound healing, and never to recovery with free movement. The joints of the upper limb allow greater latitude because subject to less strain. Strong, sound, fibrous ankylosis is a late development, at the earliest *a year or more after the active disease is over*.

The toxins of tubercle bacilli have so depressing an effect upon bone cells that osteogenesis does not occur except at a distance in space from an active tuberculous focus or a long time after its activity. This must be remembered by the surgeon whenever arthrodesis is required, for successful fusion depends on active osteogenesis and the cells will not build bone unless the design of the operation and the time of its performance are wisely chosen.

POSSIBLE RELATION TO INJURY

Medico legal questions may arise as to the part played by injury in causing the lesion. In this connexion the time relationship between an injury and the appearance of signs and symptoms is important. A few years ago the author was the subject of an accidental experiment in which the time data are reliable. On 2 in 26, while extracting some carious bone with a long gouge from the depths of a hip with severe pyogenic infection, he embedded the gouge deeply in the pulp and periosteum of his left middle finger. The wound healed by first intention and, with the danger of sepsis over and that of tuberculosis unsuspected, he gave the finger some hard work during the next few weeks. The area of the wound was a little tender, but no more than expected. *Ten weeks* after the implantation, however, the swelling and discomfort were sufficient to make him feel that a diagnostic excision of tissue was advisable. This was done (24 v 26) and a very long search resulted in the discovery of one or two tubercle bacilli. He hoped that the focus had been removed, but unfortunately *seven weeks* later he felt something 'go' while playing cricket: he must have ruptured the granuloma, for bacilli travelled up the lymphatics, producing a large tender gland in the posterior triangle of his neck, they also infected the tendon sheath. It is to be noted that amputation of the finger (10 vii 26) and good home conditions have concluded the experiment!

The period of incubation may, however, vary considerably, and there is evidence to suggest that the lesion develops more rapidly in patients with poor resistance. Probably it would be fair to say that local injury can be

excluded from casual relationship with the lesion unless it occurred more than a month and less than six months before the development of the first symptoms. The nature and degree of the destructive changes give a general indication of the minimum time period since local infection.

A local lesion extends by killing and invading the surrounding cells and tissues and only at its early stage are the bacilli in communication with lymph channels; later the bacillary agglomerations are everywhere surrounded by cellular infiltration. The regional lymph glands may be, and probably are, infected as a result of the original deposit or deposits, for there may have been several in the area. But regional glands seldom show signs of subsequent infection; whereas if the bacilli in the local lesions were free to pass up the lymph channels the glands would be persistently and heavily reinfected.

SITE OF INFECTION

1. Bone.

The focus which arises in a bone as a result of the growth and development of a colony of tubercle bacilli may occupy various positions, see Fig. 1.

There may have been a shower of tubercle bacilli over a considerable area, and the vast majority will probably have been swept away into the lymph-stream or successfully encapsulated. We are concerned with the survivors. Favoured, perhaps by infarction or bruising, the bacilli deposited at one spot have been able to secure a hold and form a colony.

The lesion then may be

- | | |
|--------------------------|----------------------|
| (1) diaphyseal (rarely), | (4) juxta-articular, |
| (2) metaphyseal, - | (5) epiphyseal, - |
| (3) juxta-epiphyseal | (6) articular. |
| (a) epiphyseal side, | |
| (b) perforating, | |

Whilst this anatomical distribution is put forward as a necessary step toward a comprehensive grasp of joint tuberculosis, the practical considerations are far simpler.

SECTION OF KNEE JOINT

Diagram composed
from radiographs
showing original
foci:

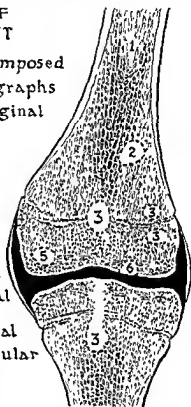


FIG. 1. Localization of lesion.

Firstly, there are the straightforward cases of tuberculosis of a bone nowhere near a joint, e.g. the sternum or the shafts of long bones, such as the metacarpals and metatarsals, phalanges, and, more rarely, the radius and ulna. Still more rare is a lesion of the skull apart from the mastoid.

Secondly, there are the bony lesions which endanger a diarthrodial joint, these will be considered with joint disease, first in general, then regionally.

Thirdly, in a class by itself, there is spinal caries or Pott's disease, with its most important complication, Pott's paraplegia. This will be considered last of all.

A bone focus nowhere near a joint, and clearly neither irritating nor infecting it, may cause indefinite pain and local tenderness, or, in a rib, for example, may produce an abscess without premonitory symptoms. Much more rarely a fairly widespread diaphyseal infection occurs.

2. Joint.

The infection of the joint may be *direct*, in which case bacilli will develop in and round the synovial membrane or just where the synovial membrane and the bone meet, or *indirect*, as when the infection reaches the joint after infiltration and erosion of bone. With this second type, which may be termed osseous, the prognosis is relatively unfavourable. For while a joint without radiographic evidence of bone erosion can recover movement, a joint infected via an osseous focus is seldom soundly healed without full ankylosis.

There is an intermediate group, which might be termed *juxta articular*, here the original infection involves the junction of the synovial membrane and the bone. Such cases are probably subject to the relatively favourable (synovial) prognosis with early and effective treatment, but tend to become osseous and therefore unfavourable, if the disease advances.

(a) *Extra articular*

This is a lesion fairly close to a joint with or without signs or symptoms of irritation or of infection. The distinction is difficult and the author feels that in tuberculosis *irritation is a proof of infection*. It is his experience that *if the joint is irritated it is infected*, that in tuberculosis 'arthrism' is arthritis. Radiographically, the lesion may appear truly extra articular and the joint normal (see Fig 5), but in cases where definite symptoms and signs of arthritis are present the result of erosion of the focus by an extra articular route is almost always disappointing. Before very long, radiographs begin to show articular erosion. The lag between infective invasion and visible erosion is misleading: in reality the bacilli invade and infect the bone spaces some weeks before they break up the bone structure. Disuse atrophy is widespread and gives no indication of the limits of infection. In such cases the author agrees with Calve that the first step is prompt conservative general and local treatment. The progress of the condition can be seen with increasing clarity in a series of radiographs.

Occasionally genuine extra-articular foci are discovered when skiagrams have been taken because of pain of endosteal and not arthritic origin. Here erosion of the focus by a safe route is indicated.

(b) *Articular.*

1 *Osseous* From foci definitely osseous, large enough to be visible in radiographs, which open into a joint through the articular cartilage

This group, unfortunately, is both the biggest and the most destructive of the joint. It is destructive because the lesion cannot heal soundly so long as there is movement of the joint. These points are discussed later.

2 *Synovial* (i.e. without radiographically visible foci) In children this is a hopeful group, for there is good prospect of restoration of function. The infection may be purely synovial and perisynovial, and if there are bone lesions they are minute and of the juxta articular type, i.e. situated round the synovial edge and not involving any articulating part of the articular cartilage. Clinically they are indistinguishable from the others.

For the author's experiences of a series of end results in the knee refer to Tables 19 and 20, pp 167 and 168.

LYMPHATIC TUBERCULOSIS

This is relatively open to the blood, toxæmic and bacillaemic. Active lymphatic tuberculosis is associated with blood showers of tubercle bacilli. The frequency of these showers probably varies with the activity of the disease. In animal experiments with active progressive disease, tubercle bacillaemia is almost constant, and in fatal human cases tubercles of different ages can be demonstrated *post mortem*. The frequency of bacillaemia in human tuberculosis as evidenced by positive blood cultures has been the subject of some controversy. Lowenstein¹ demonstrated a very high frequency, whereas Wilson² considers that positive cultures can be only obtained in 2 per cent of cases of non pulmonary tuberculosis.

Glands which are breaking down from tuberculosis are likely to cause bacillaemia because the debris follows the flow of lymph into the thoracic duct and so into the blood stream.

The frequency of bacillaemia contrasted with the rarity of new foci is reassuring evidence of the quality of our defence elements.

COMPLICATIONS

(i) Other tuberculous lesions

(ii) Genito urinary and other sequelae of prolonged decubitus

(i) Active tuberculous lesions other than the primary lymphatic infection are not often associated with tuberculous disease of the major joints or spine, and an established degree of pulmonary tuberculosis very seldom follows bone or joint disease. Indeed, in adults we see a skeletal lesion following a

¹ Lowenstein, *Munch Med Wchnschr* 1931, 78, 261

² Wilson, *Med Res Council, Spec Rep Series*, 1933 no 182

pulmonary more often than the reverse. In such cases the joint lesion will often appear unusually mild and painless—be comparable indeed to a metastatic joint in pyaemia. But this is not always so, and the treatment, conservative or radical, must match the quiescence or the destructive and toxæmic activity of a secondary lesion. It is a matter of careful assessment with a bias toward conservatism.

Nevertheless, the possibility of associated tuberculous lesions should always be borne in mind, and where there is any hint of trouble a thorough clinical and radiographic examination should be carried out.

Meningitis or generalized miliary tuberculosis is, fortunately, again a rare occurrence in an open air hospital. In the tables referred to above it will be seen that of 319 cases of spinal tuberculosis in hospital, and followed up afterwards there have been 12 instances of tuberculous meningitis during the period under review, and it is reassuring to note that meningitis has not resulted from operations on tuberculous bones and joints. The experience of the author lends no weight to any argument against operation in these cases on the ground of risk of setting up a general or meningeal tuberculosis.

(u) In this category are to be remembered the factors predisposing to renal calculus (see p. 17), and the ascending urinary infection particularly associated with paraplegia.

Lardaceous disease, so common in the old days, is now rare, but is only too ready to develop if tuberculous sinuses are allowed to become infected. Indeed, deeply infected sinuses associated with toxæmic manifestations should be dealt with by expert and radical operative methods.

CHAPTER II

DIAGNOSIS

THE patient's 'history' will often help diagnosis. Attention should be directed to the story of the onset, the duration of symptoms, any loss of weight or energy, the occurrence of night cries, and the character of the pain, if any. The family history may reveal contact between the patient and an open case of tuberculosis. A young child with tuberculosis and without such contact will probably be a consumer of raw milk.

It is characteristic of tuberculosis that the symptom which first insinuates itself upon the patient's attention, or the parents' notice, does so very gradually. The patient very seldom associates the beginning of his trouble with any particular day; if, for instance, he says it began on a Tuesday, the condition is probably not tuberculous!

Another very helpful point may be the relationship of the onset with an injury. If the patient, or parent, tells you that he, or his child, has fallen and bruised his knee six to eight weeks ago, and that 'ever since then' it has been painful and troublesome, we can eliminate tuberculosis. But not so if the injury took place two or three months before, and there has been a completely quiescent period of six or eight weeks between the injury and the first symptom.

Generally the first thing noticed by the patient or parent is an interference with function, and some swelling, rather than pain. Indeed, pain and tenderness are slight at first, the characteristic features being limitation of the full range of movement and a swollen, warm, and somewhat tender joint, with the enlargement due to swollen synovial membrane rather than to fluid.

The inquiry may have revealed

- 1 The likelihood of human infection
- 2 Previous manifestations of tuberculosis
- 3 Some loss of health and vigour
- 4 *A history of an injury from six to twelve weeks previously, with a normal joint during most of the interval*

CLINICAL EXAMINATION

Observe closely how the patient stands, walks, sits, or lies, and the position and movement of the joint in use and in repose. Loss of function comes earlier than pain, and a certain caution in movement will often be found significant.

The presence of swelling of a joint without redness of the skin or much fluid in the joint, with little tenderness and slight increase in warmth only, forms a clinical picture strongly suggestive of tuberculosis. After making these observations the examiner should try very gentle passive movements. Nothing is to be gained by attempts to force movement, and movements

under anaesthesia stand condemned if tuberculosis is suspected, because the anaesthetic eliminates the protective muscular spasm. One may get a little information, but at the cost of doing a good deal of harm.

The degree of pain on movement varies considerably. If the joint has been put at rest for some days there may be deceptively little discomfort when the surgeon handles it gently. But, as a rule, movement is much limited by muscular spasm, e.g. in the hip the pelvis moves with the limb. The characteristic sign of inflammation of a joint is this lack of movement, or limitation by muscular resistance of movements in all directions.

The position of the joint should be carefully noted, for, at an early stage of inflammation a joint will often be held in a characteristic position, that which most relieves the pain due to fluid distension. Later, when the joint is completely disorganized, the deformity will depend on posture, on gravity, and on the pull of the most powerful muscles. The position of the bony points should then be noted and the limb measured to detect any subluxation or shortening. In examining the legs, care must be taken to see that the pelvis is horizontal before measurements are taken. Muscular wasting is often obvious, but, nevertheless, circumferential measurements should be taken.

On admission the patient is again thoroughly examined and X rays are taken. The affected part is put at rest by suitable splintage, and if the diagnosis is in doubt further tests are carried out.

In children the Mantoux intradermal test is a valuable procedure in that a negative result will practically exclude tuberculosis, but it is only in young children that a positive result can be considered of any particular value. The test should be tried with 1:1,000 dilution, and if this is negative repeated with 1:100 dilution.

In both children and adults it may be thought advisable to carry out tests for syphilis and in adults for gonococcal infection, but positive results do not in either case eliminate the possibility of tuberculosis.

If there is an abscess or fluid in the joint it should be aspirated and, if neither cocci nor bacilli can be discovered, the fluid centrifuged and a guinea pig inoculated.¹

If there is no positive evidence of tuberculosis, septic foci should be searched for and eliminated, e.g. in a child a pair of unhealthy tonsils may be found and in due time enucleated. If the diagnosis is still uncertain, children are treated continuously on a 'provisional diagnosis', the continuity is a matter of principle because most of the symptoms subside deceptively soon after immobilization has been started. The alteration to a definite diagnosis of tuberculosis commonly depends on an unfavourable response to careful tests or on changes seen in a series of radiographs.

¹ Accuracy of Guinea pig Inoculation in cases of Synovial Fluid from Tuberculous Knees.
Sundt J B & J S 13, 740 (Out of 37 cases of chronic arthritis of the knee inoculation of the fluid into a guinea pig was negative in 32 and of these 8 were proved subsequently to be tuberculous i.e. negative results were ultimately proved inaccurate in 25 per cent. of cases.)

In adults a relatively quick and definite diagnosis is advantageous, and to this end diagnostic operation on joint or regional gland may be indicated

Radiography.

The bone atrophy of tuberculosis is more rapid than that of disuse and may be significantly localized, but unfortunately radiographic evidence lags behind infiltration, for there is a delay of some weeks or months between the actual invasion of the bone tissue by tubercle bacilli and demonstrable erosion of the bone trabeculae, negative X ray evidence is therefore not reliable

Just as the tuberculous infection of a part is insidious, in the sense that it does not arrest the attention of the patient, so too its action on the bone is unprovocative of an osteogenetic reaction. A pyogenic invasion of a bone makes its presence felt within a few hours, and in a few days there is bone destruction. On the other hand, bone may be infected and its spaces infiltrated with tubercle bacilli without any striking clinical or radiographic changes. For weeks the symptoms and signs are scarcely perceptible, infiltration and decalcification go on unseen, and enable the disease to get a long start on the diagnostician

PROVISIONAL DIAGNOSIS

Since the nature of the disease is such that an early definite diagnosis is impossible we must put up with a *provisional diagnosis and act on it as quickly and stringently as if it were definite*

The advantage of a 'provisional diagnosis' and decisive action is very great, and may well mean all the difference between perfect recovery with free mobility and a stiff joint in a wasted limb. In former times the diagnosis was not made until after symptomatic treatment of the early synovitis had failed and the signs of tuberculosis had become unmistakable

Radiological evidence of decalcification and erosion were regarded as standard features of articular tuberculosis, and unless these appeared, or laboratory proof was forthcoming, the diagnosis of tuberculosis was quite properly regarded as dubious. Our modern attitude is that a provisional (dubious) diagnosis is fully justified if it helps the child to the normal use of his joint again. There is so great a contrast between such a result and the stiff joint and shortened limb of a child who has been treated expectantly, by patchwork periods of rest and expectancy, until radiographs have made the diagnosis clear and admission to an open air special hospital has at last seemed warranted! This does not happen if the cases are admitted immediately to an orthopaedic hospital 'on probation'. Ready co operation between doctors and hospitals and between general and orthopaedic hospitals will bring this about, and give the cases the best prospect of recovery with normal function, or at least with minimum damage

In the synovial group, then, we are without radiographic help. The early signs and symptoms are so slight and unalarming that it is hard to persuade oneself, and still harder to convince the patient and his parents, of the

necessity for his admission to hospital. One is tempted to hesitate, to try a month or two in plaster, and so on. Such patchwork may cure the transient arthritis but it ruins the chances of a tuberculous joint, and at this stage one cannot tell which is which, and must therefore play for safety. To hesitate is to be lost, for after a month or two of immobilization the joint appears deceptively normal. This disappearance of signs and symptoms is indeed a standard trap in the diagnosis and treatment of tuberculosis of bone and joint. It is so tempting to treat the signs and symptoms and to remit treatment when they disappear so deceptively. And synovial tuberculosis readily enters into this game of cat and mouse. Indeed, the disappearance of all signs of inflammation after a few weeks of immobilization should be regarded as part of the normal clinical picture of synovial tuberculosis. Thomas offered us our safeguard—the *secondary diagnosis*, see p. 21.

Diagnostic operation, by arthrotomy or removal of an enlarged regional gland.

The indications for a diagnostic arthrotomy have not been settled, therefore a few years ago the author sent a number of his colleagues a questionnaire 'Do you do a diagnostic arthrotomy? If so, what is your procedure?' That the indications had not yet been agreed on was clear from the answers 'Often' or 'always', 15, 'No' or 'never', 15, 'Rarely' 'Occasionally', 'Only in selected cases', 13. But the answers have enabled him to outline the indications and contra indications. To begin with it should be understood that diagnostic arthrotomy is not without danger to the patient, and may misdirect the diagnosis. For, unfortunately, a diagnostic arthrotomy is by no means always decisive and purely negative findings must be regarded as provisional, since the bacteriologist or guinea pig returns a negative report if the *particular material supplied is not infected by tubercle bacilli*. For the *characteristic histology is only seen when tubercle bacilli are themselves present (though perhaps not easily seen) in the microscopic field*. This is analogous to the radiological position. And purely negative reports from the histologist, bacteriologist and guinea pig ought to be classed with negative reports from the radiologist.

Then again both Osgood and Ober¹ report that the wound may break down and give rise to prolonged trouble. It is clear that there is danger of tuberculous infiltration of the wound track outwards, followed by pyogenic infection inwards. The former is a slow affair and can always be prevented by arthrodesis within a week or two of the diagnostic arthrotomy. It must be true to say that diagnostic arthrotomy is safe if a positive diagnosis of tuberculosis will be quickly followed by fusion and dangerous only when conservative treatment will be continued despite a positive diagnosis.

The author suggests that in young children a clinical diagnosis, carefully tested and reviewed, is all that is needed. arthrotomy is contra indicated,

¹ Personal Communications

for it is risky and unnecessary In children persistence of a chronic decalcifying arthritis is sufficient for all practical purposes

It has been pointed out by Seddon¹ that in the early stages of a bone or joint lesion one or more of the regional glands may be infected and enlarged and that the excision and examination of such a gland by microscopy or guinea pig inoculation will give positive information without the need for operative exposure of the joint

Diagnostic operation.

This measure is indicated when diagnosis cannot be reached by other means and there are good reasons for avoiding delay

In children exact diagnosis is rarely urgent, and, as has already been stated, arthrotomy is only indicated when the patient is ready in stage and in age for fusion At an earlier stage the removal of an enlarged regional gland is preferable

When an arthrotomy is done attention should be paid to the following points

- (a) Ample incision into the joint for inspection of *synovial* membrane and articular surfaces, or, if the signs are localized, a smaller incision in that region The surfaces of the wound should be carefully protected from contamination by the maternal from the joint
- (b) Discovery of the most diseased part and removal of a generous sample of this for histological examination
- (c) It is well to ask the pathologist also to be generous in his supply of material to each guinea pig, for the infection may be slight and scattered

Comparison of laboratory methods.

Prof A D Gardner, a bacteriologist who has made a special study of this subject, has furnished the following table dealing with examination of portions of synovial membrane removed at arthrotomy in 18 cases which proved tuberculous

TABLE I

	CASES	PER CENT
<i>Positive histologically</i>	17	94
One case was negative histologically and by guinea pig but proved by finding T B in smear		
<i>Positive by guinea pig test</i>	13	72
Positive histologically	4	22
Negative by guinea pig		
Negative histologically		
Positive by guinea pig		

N B —For histology, from one to four selected blocks of tissue were prepared, one if the tissue looked obviously tuberculous, several if it appeared doubtful

¹ Seddon H J, *British Medical Journal*, 21 Jan, 1939 p 105

Thus, Prof Gardner's experiences show that a pathologist experienced in tuberculous material, who is prepared to take time and trouble, is at least as good as a guinea pig in finding the bacilli in fluid and a diagnosis from tissue. A portion of tissue sufficiently infected to give a guinea pig tuberculosis will show tubercle bacilli or be histologically characteristic of tuberculosis.

CHAPTER III

THE GENERAL TREATMENT OF THE DISEASE

We have as yet no means of developing the specific active immunity of our patients. General treatment comprises the skilled use over a long enough period of four natural remedies—rest, food, the sun, and the open air.

FOOD

Food must be adequate but not excessive, well cooked, attractive, and appropriate to the weather. Our patients do not need fattening unless they are too thin; they should be very little above their normal weight. The diet should be simple, well mixed, and pleasantly served, as regards this last point it is worth mentioning that the probationer may have to exercise a good deal of tact and charm in feeding the frailer sort of child.

Our patients are very much exposed to the weather, and when it is cold, require more food and especially more fat. In hot weather, on the other hand, their meat, fat, bread, puddings, and suchlike should be reduced, but they should have plenty of fresh fruit, vegetables, and be persuaded to drink extra water mostly between meals, as a precaution against renal calculus (see p. 18).

THE ACTION OF SUN AND WIND

In treating skeletal tuberculosis we aim at giving our patients physical rest and metabolic stimulation, and it is to the open air, the sun, and the wind that we look for the latter. We should assess their qualities mainly in relation to this service.

It is the author's opinion that the main virtue of heliotherapy (an accepted misnomer) lies in the exposure of the patient to the varying stimulus of warmth and cold, wind and calm, and all changes of the weather.

It is this part of the treatment that can only be carried out in open air country hospitals, and it was in 1910 that the author first came across such a hospital in Shropshire. During his time in the wards of a London hospital, first as a student, then as a House Surgeon, Pott's disease and hip disease had meant deformity, septic complication, and the slow, miserable progress of lardaceous disease. In contrast to this the work of Sir Robert Jones in open air hospitals in Shropshire and at Heswall seemed miraculous. The children with tuberculous spines, hips, and knees, looked perfectly fit, and at Heswall they had not lost a patient from lardaceous disease for two years. All this was accomplished without the exposure of their bodies to the sun.

The action of the sun on the body.

1 *Its photochemical action.* (a) Synthesis of vitamin D from ergosterol: this is absorbed, and is helpful to patients with vitamin D deficiency. Vitamin D can be administered from the dispensary.

(b) Irritation advancing to destruction of very superficial living tissues the absorption of the products, within small limits and in certain cases may be beneficial. But the danger of overdose is definite, and *to febrile patients any dose is an overdose their bodies should never be exposed to sunlight*. Gross overdose in the ordinary patient is demonstrated by a rise in evening temperature.

It is only in the spring and summer that an overdose of light need be feared in temperate climates and at ordinary altitudes, and Rollier's table, designed for the Alpine sunlight is needlessly slow for our English sun. The author fully agrees with Rollier that several short exposures are better than one long one.

2 *Its heat*. A warm sun and cool wind combined have great virtues. The sun keeps the patient warm whilst the moving air cools and stimulates the skin. The effect is rather that of a long continued relatively genial 'contrast bath'. The metabolism of the skin itself, and of the muscles and viscera (liver &c.) through reflex association is stimulated. Too much heat is as bad as too much ultra violet light, for its relaxing and devitalizing effect is the very opposite of what we want. In particular, *great care should be taken to avoid any warming up of the local lesion* for that is most harmful. This danger is rather generally overlooked, e.g. a plaster containing a tuberculous ankle is repeatedly baked in the sun, if an abscess follows, the plaster bears the blame¹.

In a hot summer it is only too easy to do more harm than good by the application of the sun's light and heat to the body and even without direct exposure it may be difficult to keep the patients cool enough, in or out of doors. One way and another the summer sun can easily do more harm than good so much so that in hospitals which are ill designed or ill informed the patients do better in winter than in summer. Perhaps the most important clinical point in the design of a ward for tuberculous cases concerns its capacity to keep cool in very hot weather.

3 *Its psychological effect*. Sunshine is cheering and stimulating, but only if the patients are given adequate alternating periods in deep shade. The sun should not be allowed to shine in the patients' eyes.

4 Exposure to sun and wind dehydrate the body (see p. 17).

The wind

This is probably the most valuable component of 'heliotherapy'. The wind cools the skin by convection and stimulates it by its ever varying impact. The combination of cool moving air with warm sunshine is pleasant and like a contrast bath promotes active hyperaemia of the skin. Leonard Hill reports that in Montana the heat production of the resting subject was put up to a notable degree higher than was the case with the children at Alton in summer but not higher than the latter in winter¹.

¹ Hill Leonard *Journal of Tuberculosis* April 1929

The effect of the wind on the body is not wholly the result of cooling, for there is also the reflex stimulation of the viscera from the skin

The air bath.

'Heliotherapy' can be carried out without visible sunshine. As much as possible of the body is exposed to the open air for a period which, if it is to be the best, must be judged each time for each child. Here again is an opportunity for the probationer to contribute personally to the success of treatment.

The author has great faith in the value of air baths all through the year, and he thinks it probable that the ordinary English weather, applied to the skin in well regulated doses, will be found as effective in the treatment of tuberculosis of bones and joints as that of other climates, and more helpful than indoor artificial sun.

Through the winter the patient should have three or four air baths a day. In very cold weather he should have just a few seconds exposure of the body to a touch of keen wind, never long enough to cause a harmful chill. The air bath should give an enjoyable cooling stimulus and be followed by a reactionary glow.

Our Ward Sisters should be taught directed, and even compelled to use the wind and open air up to the optimum in the winter, and warned often and forcibly against the danger of the sun in summer except in the early morning and in the evening.

THE EFFECTS OF PROLONGED DECUBITUS

1. The blood.

With open air and a well balanced diet the blood picture tends to become normal.

2. The cardiovascular system.

It is, of course, well known that after prolonged decubitus, patients cannot be raised to the vertical position without faintness. The normal control of the circulation in relation to changes of position is out of action and has to be re-educated. Furthermore, patients who have been for a long time on their backs are more than ordinarily sensitive to shock during or after operation. On the other hand the blood pressure does not greatly vary from normal. Fig. 2 shows a series of the systolic blood pressure records of patients before operation.

3. The kidneys.

Renal calculus is a dangerous, but largely preventible, complication of prolonged dorsal decubitus. There are three main causes.

First, the posture of the patient produces a small stagnant pool in the pelvis of the kidney.

Secondly, exposure of the body to the sun and the open air leads to

dehydration of the body, stagnation and concentration, and makes for precipitation

Thirdly, in Pott's paraplegia the urinary tract may become infected

In the author's own hospital, where 90 to 100 patients are more or less constantly on their backs, we have records of 8 cases of stone in the last ten years. During the last five years, since we have been more alive to the danger, there has only been 1 case. Key¹ has made an analysis of renal complications. He investigated 162 cases which had been immobilized for three

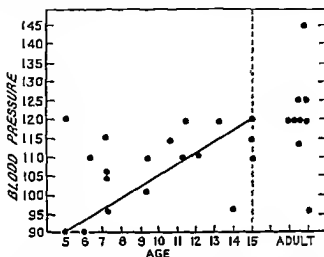


FIG. 2 The blood pressure of patients at various ages is indicated by circles and the approximate normal indicated by a black line. The vertical figures indicate the blood pressure, the horizontal the age. It will be seen that of the children, nine readings were high, three low, seven near the line; of the adults, one was high, one low, and, again, seven near the line.

months or more. In these the incidence of renal complications was 19.1 per cent. Of 38 comparable cases of less than three months' decubitus, there was only 1 case. The 19.1 per cent represented 32 cases, of whom 20 were stone, 3 renal tuberculosis, and 9 pyelitis.

The most important sign of renal calculus is haematuria, and Ward Sisters should be instructed to examine the first samples of urine of every frame or plaster bed patient after each 'turning'. Haematuria is an indication for careful X-ray investigation.

Renal calculi can generally be prevented; several simple precautions must be taken:

1. The patients must be persuaded to drink more water than they want.
2. Patients must be tilted or turned periodically. Practice differs widely in this respect. The Pugh frames are mounted so that the patient can

¹ Key L. A., *The British Medical Journal* pp 1150-3 6 June 1936. See also, 'The Prevention of Calculus Formation in the Treatment of Tuberculosis of Spine and Hip' (*Annual Report of the London County Council* 1933 Public Health vol 4 part 3, p 38).

easily be tilted to a sufficient angle, first one way for 20 minutes then the other, several times a day. Here the patient is 'turned' formally (see p. 126) once a week after the initial two months.

The very serious complication of paraplegia presents an altogether different problem which will be considered later.

Many of these so called stones are for a time, at least, more mud than stone, consisting of a mass of precipitated material which can be fairly easily washed away by the 'water cure' and by changing the posture to the ventral position or by frequent rotation.

4. The skin.

Bed sores used to be a common effect of prolonged dorsal decubitus. In orthopaedic hospitals they are now very rare. This is largely due to the expert nursing of frames, plaster beds, and so on.

5. The mind.

What is the psychological effect of prolonged dorsal decubitus? Taken alone it could not be other than depressing. But one can at least do one's utmost by the design of wards and their direct access to grass and games and life, and by opportunities for occupation to make time pass purposefully and pleasantly. For, indeed, Nature seems to give an extra allowance of patience and courage to match the tedium of prolonged dorsal decubitus.

CHAPTER IV

THE LOCAL TREATMENT OF THE DISEASE

HERE our aims are

- 1 To correct any deformity and to favour local healing by rest in a carefully chosen posture
- 2 To restore free movement whenever possible, or, if that is impossible, to bring about sound ankylosis
- 3 To remove diseased parts or tuberculous pus when necessary
- 4 To prevent secondary infection

When treatment is complete we expect the patient's limb (or spine) to be *so well and soundly healed that it will be permanently safe, and with its ultimate function so well provided for that, at the end of treatment, it is freely, strongly, and permanently useful*

We shall see that in most joints these conditions of permanent safety and maximum utility can only be achieved by *free movement or sound bony ankylosis*

Our means are various, but the basic principle of local treatment is '*Rest, enforced, uninterrupted, and prolonged*', as H O Thomas taught us. And this 'Rest' includes relief of each constituent part from the strain of its own particular function, for the *inflamed synovial and perisynovial tissues* it means *stillness*, for the *decalcified and eroded bone* it means *relief from pressure*, and for the *fibrillated and softened articular cartilage* it means *relief from friction and from pressure*

The splintage should

- 1 Hold the parts accurately and comfortably in whatever position is chosen
- 2 Allow free circulation in the affected part
- 3 Allow free respiratory movements
- 4 Allow as much exposure of the surface of the body as possible to the air
- 5 Be as simple, inexpensive, and widely applicable as possible. In the application of this splintage, great care should be taken to avoid producing secondary deformities of other parts, and, when prolonged decubitus is necessary, everything possible should be done to eliminate stagnation as well as concentration, of the urine
- 6 In spinal cases, allow access to the back whenever necessary without risk of local strain or movement, and, where bone destruction has made a local kyphos inevitable and even desirable for the sake of sound healing and stability, enable it to be minimized and localized, and compensatory curves to be developed

But there is no such thing as fool proof splintage. Nor can the use of the

various splints, frames, and plaster beds be easily learnt out of a book. Every surgeon responsible for these cases must learn by close personal attention and by taking every opportunity of discussion with old hands at the craft whether they be his senior colleagues or his Ward Sisters. He must know every danger and how to avoid it by the use of the requisite pad or pull, what must be done and what must not. If his patients are to be on frames in a hospital unused to frames, he will run up against trouble unless he is fully competent to 'nurse' a frame himself.

Sir Robert Jones, by practice and precept, gave his great authority to H O Thomas's prescription of '*Rest, enforced, uninterrupted, and prolonged*'. Each word of this pronouncement must be given its full value. When we remember that Thomas's father was a successful bone setter, and that previous to his qualification he assisted his father for a year or two, his deliberate and conservative methods have added significance.

It is possible to adopt traction, or non tractive direct splintage. Thomas had a great dislike of plaster, his open splints for the spine and hip were efficient, and Sir Robert Jones made them comfortable. On the other hand many of us find the advantages of the application of plaster, to certain parts and at certain stages, greater than its disadvantages. But most modern orthopaedic surgeons wisely lay great stress on the value of being able to expose a large area of the body to the air. Then again we owe to Thomas an emphasis upon the *continuity* of splintage from the moment when a tuberculous diagnosis has been made to that period, generally at least twelve months later when some modification of the enforced rest can be allowed with safety. Thomas was insistent on what he terms '*the secondary diagnosis*', i.e. *an ascertainment of recovery*. He put the matter thus: 'But it has been overlooked that we ought before releasing the patient from our control, to make a supplementary diagnosis and ascertain that there exists no longer any remnant of the ailment previously diagnosed.'

Thomas had no radiographs to help him: he acquired, and he can still teach us to acquire, by observation and careful tests at the appropriate time, a sure assessment of the progress of the patient. Even now, with all our X ray and laboratory assistance, his methods offer us certain safeguards which we cannot afford to neglect. Indeed, a great deal of judgement may be required to decide, in any particular case, when disease is safely arrested. One is guided by the patient's general appearance, temperature chart and, above all, by the changes shown in a series of radiographs, and locally by the absence of any heat, swelling, or tenderness. The radiographic signs of healing include recalcification and the increasing definition of the outlines of eroded areas.

The author has already stated his belief that either free mobility or sound bony ankylosis should be our aim, and that only so can we be sure of permanent safety to endure the rough and tumble of life. If then the joint surfaces have been seriously damaged it is no longer a question of when we can safely allow movement again. The problem is now one of deciding how best

¹ Thomas H O *Contributions to Surgery and Medicine*, 1887, Part 3 p 4

to favour, or bring about, sound bony ankylosis. This involves a change in the application of rest, in that, while immobilization is kept up, interarticular pressure is permitted or even encouraged. As natural bony ankylosis is almost unknown in tuberculosis, operation will often be indicated. In young children it may be advisable to wait some years before operation can be wisely undertaken, and in such cases we can, in due time, adopt a form of ambulatory splintage.

On the other hand, whenever the absence of articular destruction leaves a hope of the restoration of movement there comes a time when the joint is set free provisionally for Thomas's tests. Thomas taught that a joint which, when set free, gains in range of movement is no longer inflamed and is doing well. On the other hand, persistent 'stickiness', i.e. a reflex muscular resistance to passive movement or a diminishing range of movement, is a sure sign that the inflammation is still active and that immobilization must be reinstituted and maintained for another long period.

In children, when inflammation is quiescent and erosion has ceased, there comes a healing stage. There is now a constructive hardening of the granulation tissue, which has hitherto been a partially organized infiltration of cells, animated by a reaction to inflammation. During this sclerosing stage one can often allow a little movement, but cannot safely allow the pressure of weight bearing. Then, later, if all goes well, comes the release from all restraint and protection. This convalescent stage is recognized by Thomas's tests and by radiographs.

Unfortunately in the majority of tuberculous joints, destruction is progressive until it has become clear that all hope of safe mobility has gone, and that only by ankylosis will the lesion be safely and soundly healed. Furthermore, we know that bony ankylosis does not happen in tuberculosis, and that most joints on which considerable strain is thrown will seldom heal soundly without operative arthrodesis.

Children heal better than adolescents, adults heal slowly, and the elderly never achieve a final arrest. In children, conservative treatment is carried through to its conclusion, both because they heal better than adults, and because they stand long continued hospital treatment better in body, in mind, and in worldly circumstance. But in adults operation is interposed as soon as general and local conditions allow because they heal poorly, slowly, or not at all, and because they do not bear long continued hospitalization well. But even in some children the time comes when it can be foreseen that, without operation, healing will be delayed, uncertain, and probably unsound.

The need for operation is often obvious from the first. In an adult, for example, it is no good whatever hoping for the natural restoration of movement in a tuberculous hip, knee, or ankle. In some joints the infected tissues can be completely excised; in others an extra articular synostosis can be brought about. Provided that this removes all strain from the joint, the patient can be allowed up as soon as his general condition will benefit thereby. We can then accept the principle that operation will accelerate sound healing.

and often bring it about when it would not otherwise take place, but we can not afford to forget two vital principles

- (1) that the operation on a joint has no direct influence on the deep seated lymphatic tuberculosis, and
- (2) that the operation will be far more certain of success if it is done at a stage when the general condition of the patient is at its best and the local lesion is no longer active.

One ought then in general to wait for health and for X ray evidence of recalcification. But operation may be indicated for a different reason, not at a chosen moment and at a favourable stage, but because the local lesion remains active in spite of treatment, and because the toxæmia is itself a danger to life and a bar to recovery. For example, one may feel it advisable to perform thorough excision of the focus in the hip, or excision of the knee in older patients in order to give relief from a massive tuberculous focus. One should not hesitate to amputate the leg of a man over 40 with a widespread active tuberculosis of the tarsus.

Again, in caries of the dorsal spine in an adult there may be persistent pain which cannot be controlled by a frame or a plaster bed because it is associated with respiration. In such cases the movements of breathing seem to be concentrated exactly at the point of somatic destruction. The author has actually seen this movement taking place two or three times while clearing the debris round the lesion after costotransversectomy. Raw infected bone above and below was being ground together. This harmful and painful grinding can be quickly relieved by strong posterior bone grafting, and finally eliminated when posterior fusion is complete. Then, too, paraplegia may call for operation at any stage of the disease.

One cannot lay down a period for operation which will be universally true, for the indications and the circumstances vary with the individual case ✓

CHAPTER V

OPERATIVE TREATMENT

- A For Diagnosis (already considered in Chapter II)
- B For Cold Abscess
- C For the Prevention and Treatment of Secondary Infection
- D Directed toward the elimination or healing of the Focal Disease, these include
 - (i) Treatment of extra articular bone foci,
 - (ii) Excision or erosion of joint disease with intra articular arthrodesis,
 - (iii) Extra articular arthrodesis, alone, or in addition to the above,
 - (iv) Wide excision of all infected parts with subsequent pseudarthrosis, or amputation
- E For the Correction of Deformity
- F For Paraplegia (to be considered later in Chapter XVII)

TREATMENT FOR COLD ABSCESS

An abscess can be harmful both from the toxæmia it produces and from its pressure on vital structures such as the spinal cord, it may further be threatening on account of prospective rupture and the danger of secondary sepsis. The treatment of a retropharyngeal, mediastinal, lumbar or psoas abscess will be discussed later (see p 102)

In general, an abscess of any size should be aspirated with the strictest aseptic and antiseptic precautions and, if the abscess is near the surface, through an oblique path. The fluid withdrawn should be examined by culture and smear.

If the fluid is 'flocculent' and aspiration proves impracticable a modifying fluid¹ may be injected with the object of thinning the contents and making them susceptible of aspiration. But frequently aspiration is unavailing, perhaps most often in the ankle, wrist, foot, or hand, then comes the choice between opening, evacuating and closing or opening and allowing leakage. In our experience a sinus need no longer involve septic infection, thus most serious complication can be prevented by sufficiently careful technique,

¹ The author does not himself advocate the use of modifying fluid but he wrote to Sir Henry Gauvain who stated his views as follows: "I still occasionally use a modifying fluid for cold abscesses. The most usual one is sold by the British Drug Houses under the name of Formulaion Iodoform Co. Alton. The formula is iodoform 5 grammes ether 10 grammes guaiacol and creosote 2 grammes each and sterilized olive oil 100 c.c. I inject from 5 to 20 c.c. starting with the smaller dose. This is used for abscesses containing thick pus which is rather difficult to evacuate. For abscesses with very thin pus and with thin walls where you want a sclerosing effect I use 10 per cent iodoform powder in sulph. ether. After aspirating the fluid inject from 5 to 10 c.c. of this solution and leave the cannula in position until all the ether has escaped. The iodoform is precipitated on to the walls of the abscess and you can take an X ray of the abscess if you wish to do so. Usually, a sort of sanious fluid appears following and requires aspiration in three or four days time."

including the use of a special antiseptic both at the operation and afterwards at every subsequent dressing. After its evacuation the cavity is allowed to leak and any form of rubber or gauze drain is abhorred; the incision is of good length, the whole length of the subcutaneous cavity and is not sutured. Afterwards every subsequent dressing is done with a very careful aseptic and antiseptic technique of which the special points are

- 1 Masks for the dressers to prevent droplet infection
- 2 The use of a skin antiseptic made of 1 per cent crystal violet and 1 per cent brilliant green in (75 per cent) alcohol
- 3 The use of *plenty of sterile non absorbent dressings with very thorough bandaging* to make sure that the dressings will not be disturbed
- 4 Infrequent dressings for a few days daily dressings may be necessitated by profuse discharge but in the absence of pyogenic infection there is soon very little leakage and dressings once or twice a week suffice

THE PREVENTION AND TREATMENT OF SECONDARY INFECTION

(i) The prevention of sepsis

Pyogenic infection is almost always a late complication but very rarely a tuberculous and pyogenic infection appear simultaneously¹ with the signs and symptoms of acute osteitis. Such a case must be drained for sepsis and put through the standard general and local treatment for tuberculosis.

Ordinarily pyogenic infection can and should be avoided by

- 1 Early and adequate general and local treatment which limits bone destruction and abscess formation
- 2 The aspiration of abscesses coming toward the surface in good time and by a long subcutaneous track
- 3 Meticulous aseptic and antiseptic dressing technique of any sinus

This in the Wingfield Morris Hospital has proved so reliable and beneficial that it deserves emphasis. If a tuberculous focus has been well treated and the patient is doing well the discharge from that focus will very quickly lessen and dry up. Within a few days or weeks the whole thing is healed. For a period of five years we had not a single case of secondary infection of a tuberculous sinus.

In the old days secondary pyogenic infection of a sinus was almost universal with the tragic results we knew only too well—unending illness, periods of pyrexia, profuse suppuration, lardaceous disease and a slow and miserable death.

(ii) The treatment of sepsis

Once sepsis has been established the local treatment is adequate drainage and drainage to be adequate must often be radical even drastic. The methods of carrying out this procedure vary in different regions and will be described later. While pyogenic infection is a very serious complication which should

¹The author has had one such case in twenty years.

at all costs be avoided, it sometimes, as a small compensation, provokes ankylosis, and thus brings about the sound healing of a joint

THE ELIMINATION OR HEALING OF THE FOCAL DISEASE

(i) Treatment of extra-articular bone foci.

What are we to do when there have been signs or symptoms of arthritis and X rays disclose an extra articular focus without evidence of infection of the joint? In cases in which the focus appears definitely extra articular, one is sorely tempted to curette it through an extra articular approach. Calvé has warned us against doing so until progress has made it clear that the joint is not infected. His warning concerns the danger of sinus formation with secondary infection of the joint via the sinus. In the author's limited experience of such an operation, no long continued sinus with a risk of sepsis has occurred but on the other hand, when signs of arthritis have called attention to the lesion the joint itself has already been infected with tuberculosis.

Osseous foci, quite definitely non articular, may be discovered on account of symptoms of endosteal rather than arthritic origin, perhaps an indefinite aching in a bone, or the appearance of fluctuating swelling, rather than pain or lack of function in a joint. Such a condition occurs not infrequently in the sternum, a rib, or in the small bones of hand or foot. These can be dealt with by limited surgical measures and the basic infection by general treatment

(ii) Excision or erasion of joint disease with intra-articular arthrodesis.

This is carried out in order to obtain sound, safe, and permanent healing. The arthrodesis may be preceded by the removal of all, or as much as possible, of the diseased tissues of erasion or excision. The advantage of this is that it enables the surgeon to eradicate the diseased tissues partly or completely, and to place together raw surfaces of healthy bone. In some parts, notably the knee, erasion or excision with direct arthrodesis is adequate. In many joints, however, some form of extra articular arthrodesis is essential either as a supplement to excision or without any articular operation.

Sir Robert Jones used to insist upon the difference between tuberculosis in the old and the young, teaching that, when excising a joint in a relatively young patient one could leave infected tissues, but that in the old one should regard them as locally malignant.

(iii) Extra-articular arthrodesis.

This, as its name implies, is a procedure which aims at synostosis by means of bone transplantation from a point proximal to a second point distal to the joint without opening the joint. The great advantage of this method of synostosis is that the bone bridge is at a distance from the tuberculous lesion, for *osteogenesis does not occur except at a distance in time or in place from an active tuberculous focus*. In other words, if the surgeon endeavours to get a union between two bony surfaces close to a recent, even if no longer active,

tuberculous lesion he will fail, but if he can, by a graft between the two bones, build a bridge which makes contact with healthy bone at a distance above and below the joint, osteogenesis will be unhampered

Technical principles. The methods will vary with the joints concerned, but the principal points can be stated as follows

- (a) The graft should have good contact at both ends with raw healthy bone
- (b) The shorter the bridge the better
- (c) The placing and the shape of the graft should be related to the mechanical strain likely to be imposed upon it

Not only are there good and bad technical methods in the operation itself, but also in the splintage and protection of the joint during the operation and in continuity afterwards. Finally, there must be a carefully graduated exposure of the grafted joint to the strain of use, in order that the bone bridge may strengthen until it is able to stand any load which may be put upon it

- (iv) Wide excision of all infected parts with subsequent pseudarthrosis or amputation.

Extensive disease. Now and then there may be a very large area of bone infiltrated by tuberculosis and in the end practically replaced by a granuloma permeated by tubercle bacilli. This massive disease may involve the bone at one or both sides of the joint, and the joint itself will, of course, be destroyed and its cavity occupied by debris and necrotic tissue. This may make arthrodesis exceedingly difficult or even impracticable, and may of necessity indicate *wide excision*, or *amputation*. Furthermore, even though it should prove possible by conservative measures to arrest the disease, this would at best take several years, and at the end the joint would have been destroyed, the bones shortened, and the limb wasted.

The justification for wide excision in such a case is a better prognosis, and a much quicker prospect of recovery.

Persistent active disease. Occasionally a patient fails to respond to treatment. Sometimes the local lesion alone will persist despite improvement in the patient's general health. Month after month the radiographs make it clear that further bone destruction is taking place. There is no sign of the arrest of the destruction, still less of recalcification. At other times, the patient as a whole fails to respond, remaining much as he was when admitted to hospital. Such a state of affairs is rare in children, but by no means uncommon in adults. Whereas in the former case radical excision will as a rule be successful, in the latter the problem is not so straightforward. It may be that the man's illness is due to an active lesion of a large joint, or, on the other hand, it may be that there is some other lymphatic or pulmonary lesion which is responsible. A careful general examination will be made, but even so, a great deal of consideration and good judgement may be needed in order to reach the right decision on the question of operation. The problem is sometimes of this sort. Is it probable that the local lesion is alone responsible for a man's illness and that relief from toxic absorption will enable the man to

recover from any other lesion he may have? Or on the other hand is the local lesion only active because of the man's general illness and will any operation be futile or definitely harmful?

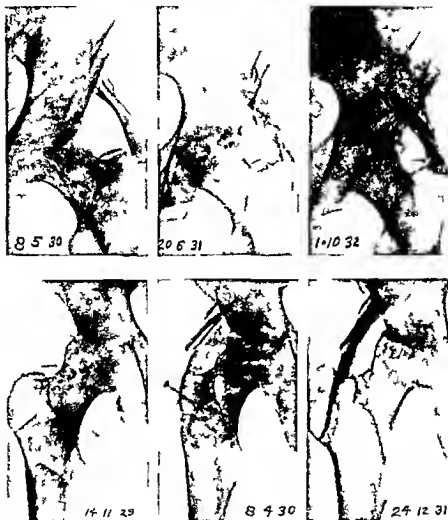


FIG 3 This figure well illustrates the development of strength in an extra-articular graft which follows adequate protection and careful re-education of the bone cells in the graft (*British Medical Journal*)

The operations that will have to be considered in such cases are radical excision or amputation.

Pseudarthrosis A very wide excision of the diseased bony parts may be necessary in certain cases so extensive that arthrodesis may be impracticable. In order to maintain length and provide the immobilization of the soft parts that favour healing strong uninterrupted traction is essential from the time of operation e.g. in the hip the upper end of the femur must be kept well away from the innominate.

FOR THE CORRECTION OF DEFORMITY

Spine.

Here the intrinsic deformity varies, as will be seen, with the extent of destruction and the site. But this organic deformity is liable to exaggeration, especially in the dorsal region, by the absence or distance of compensatory curves. Most of us aim at the elimination of all but the essential 'orthopaedic stability of Menard' by the minimization of the length of the primary kyphos and by the development of compensatory curves close above and below. Waldenstrom¹ (see Figs 53a and 53b) has gone further and succeeded in straightening the kyphos and maintaining the correction by grafting.

Lower limbs.

Here deformity can, to a large extent, be prevented by good splintage and when necessary corrected by osteotomy, but the worst and the most intractable deformity is the shortening and wasting of the bones of the limb due to (1) *destruction by disease*, (2) *atrophy from disease*, and (3) *premature closure of the distal epiphyses* of the limb. This can be countered in two ways, first by taking all possible steps to promote rapid local healing, then by arthrodesis to make a reasonably early return to function possible and safe. Secondly, one can by epiphysiodesis² check the growth in the other limb or, if much disparity remains and the case is seen too late for epiphysiodesis, lengthen the short, or shorten the long, limb.

The dangers of operation.

In relation to danger the operations are of two orders

- 1 Those done for purely orthopaedic reasons, e.g. spinal fusion, arthrodesis, osteotomy, epiphysiodesis, leg lengthening, &c
- 2 Life saving operations done to check dangerous disease, e.g. amputation, wide excision, &c

The surgeon must satisfy himself of the safety under the circumstances of an operation of the former group before deciding on its performance. On the other hand, as regards the second group, having taken every precaution, the surgeon is often right in facing grave risks.

Is there a risk of dissemination? It is of course axiomatic that unnecessary operations on sick patients should be avoided. In tuberculosis one should consider not merely the risks directly associated with the operation itself, but also that of a subsequent and, perhaps, prolonged physical depression, a state particularly unfavourable in a tuberculous patient. The opponents of the operative treatment of tuberculosis have indeed put forward the view that operation involves a considerable risk of dissemination of tuberculosis. It is, therefore, of great interest to note that during the seventeen years in

¹ Waldenstrom *Acta Chirurgica Scandinavica* vol lvi Fasc 1, 1924

² Phemister, D. B., 'Operative Arrestment of Longitudinal Growth of Bones in the Treatment of Deformities' *Journal of Bone and Joint Surgery*, 1933, 15, 1

which the Wingfield Morris Orthopaedic Hospital has dealt with surgical tuberculosis on a large scale we have no record of a case in which a new focus, or meningitis, or miliary tuberculosis, has followed an operation during the three or four months in which the operation might reasonably be regarded as responsible. During this period 464 major operations have been carried out on tuberculous patients.

We have had a case or two in which an operation was done rather as a forlorn hope in order to relieve a seriously sick patient from a painful and exhausting lesion, and some of these patients have continued to go downhill.

The author attributes the absence of dissemination after an operation, in the main, to the preparatory course of general treatment, as a rule, the patient is not operated upon until he or she is definitely showing a good resistance to tuberculosis, and it is, therefore, unlikely that tuberculous bacilli will give rise to new lesions. Two patients developed meningitis while in hospital, fortunately before, not after, operation which, if it had been done a few weeks earlier, might have been unfairly blamed.

CHAPTER VI

THE HIP

THE spine and the hip suffer from tuberculosis more often than any other part of the skeletal system, and the hip more often than any other single joint. The hip, therefore, will be considered first, and in order to avoid

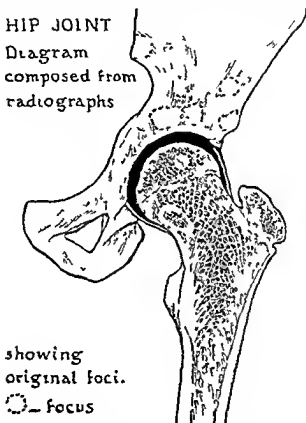


FIG 4 Diagram indicating fairly typical foci round the hip

cumbersome repetition differential diagnosis will be discussed in detail in this chapter. In the later chapters particular points in differential diagnosis will alone be taken

PATHOLOGY

A metastatic infection may be deposited in any single part, or simultaneously in several parts of the joint and its constituent bones. The foci which result may be synovial or, and it amounts to much the same thing, may be juxta synovial, ulcerating the bone where the synovial membrane joins it, or again the foci may be situated anywhere in the head and neck of the femur, or round the acetabulum, most often in its roof (Fig 4)

The localization of the original focus is sometimes of practical importance, for operation may be indicated in the case of a metaphyseal focus which appears to be entirely extra articular (Fig 5), or a tuberculous embolus may cause infarction as well as infection, the early X ray signs of aseptic necrosis being subsequently replaced by those of tuberculosis. Such an embolus,



FIG 5 A metaphyseal focus

blocking one or more of the branches of the vessels passing to the epiphysis via the ligamentum teres, may cause initially the radiographic appearance of pseudocoxalgia (Perthes' disease). Occasionally the concentration of disease in the acetabulum appears to warrant some form of acetabulectomy, and in some cases a very widespread endosteal destruction of the head, neck, and trochanteric region may indicate a wide excision of the affected parts of the femur. These points will be discussed later.

The hip is a close fitting ball and socket joint, and one of the difficulties in its treatment is a tendency for the debris of its destruction to collect in the socket, hyaline cartilage is resistant to tuberculosis, the bone under it is eroded until the articular cartilage is sloughed off and lies among the debris

collected deep in the socket, the whole forming a mass of sloughed cartilage, bone sand and pus which prevents the femur from making direct contact with the ilium. Such a joint remains unhealed, insecure, and not easily or fully protected by extra articular arthrodesis. Sometimes, however, the capsule is ruptured and the debris extruded, in one or more directions. X rays frequently reveal such extrusion sacs filled with calcareous debris. This extrusion is of benefit, for what is left of the femoral head can settle into the acetabulum—and in so doing shorten the distance to be covered by a graft and take a share in the resistance to strain.

DIAGNOSIS

History.

† A limp is almost always the first symptom of hip disease, and the limp is characteristically due to a loss of full extension of the joint. There is a moment at the end of each normal step when the hip is fully extended—now whenever there is a synovitis or arthritis of the hip this full extension is lost, and the loss is evidenced by a limp, what is termed a 'flexion' limp, of the affected limb. It is this limited extension of the hip, more than any delicacy in putting the foot on the ground or transferring body weight to the limb, which exhibits the disease. The characteristic limp of hip disease is not one of pain, it is rather one of impaired function. The limp is due to the inability of the patient fully to extend the thigh on the pelvis more than to any conscious protection of the joint.¹ At the same time the movements of the joint are not quite supple on account of the reflex hypertonus of its muscles—and this limp is quite different from the yielding dip of unilateral congenital dislocation of the hip or the carefree stumping of coxa plana after the initial arthritic stage. But it must be remembered that in an early case *the limp may not always be present on examination*—especially if the child has been put at rest for a few days. Indeed, the characteristic history is that of a limp which becomes obvious when the child is tired.

In an adult, pain in the hip, or pain referred to the thigh or the knee is the rule. This pain is severe whenever the joint is tightly distended with fluid. In a child pain is often not mentioned, but in many cases we hear of restlessness at night or 'night cries', i.e. the child wakes with a sudden whimper or cry just after he falls asleep. Such a story is very strongly suggestive of tuberculosis.

Often the patient is 'below par', and mothers will have noticed that the children have been easily tired and not at all in their best form for some months. This is, of course, associated with the primary tuberculosis of the lymph glands.

Clinical examination.

The patient should be examined lying on a firm flat couch, or, even better, on a table covered with a blanket.

¹ Robert Jones, *Contributions to Orthopaedic Surgery*, p. 123

It may now be noticed that the patient is lying with one leg apparently a little longer than the other, due to abduction, also that he keeps one or both hips a little flexed or lies with marked lordosis. For at an early stage patients often hold an inflamed and distended hip abducted and externally rotated, and always a little flexed, though this may be masked by lordosis. Later on the unrestricted result of prolonged muscular spasm will have led to adduction, but the flexion remains.

Careful comparative inspection will reveal wasting of the thigh, probably some swelling in front of the hip, and wasting and loss of firm outline in the buttock. Measurements round the thighs taken at exactly comparable distances below the anterior superior spines will confirm the wasting. Tenderness is almost always present in adults, but less constantly, though quite frequently, in children. Actual measurements from the inferior aspect of the anterior superior spine of the ilium to the tip of the corresponding internal malleolus on each side, are not likely to be different at an early stage. But owing to muscular spasm it may be impossible to get a comparable position for each hip and knee, for abduction and flexion shorten, whilst adduction and extension lengthen, actual measurements. Destruction, displacement or, in old cases, diminution of growth from disuse may be responsible for true shortening.

'Practical' (apparent) measurements are only helpful when one hip is fixed (whether by muscular spasm or by fibrous or bony ankylosis). To test this, the free limb is brought side by side with the fixed. Measurements are then taken from the umbilicus to the tip of each internal malleolus (the heel of the hand holding the tape should rest firmly on the iliac crest), the short leg being measured first, then the longer with equal tension on the tape. Any difference in the two sides must be interpreted in the light of the actual measurements. If the practical shortening is greater than the actual, the fixed hip is adducted, if less, it is abducted. The difference between actual and practical shortening when related to the distance measured transversely over the anterior superior iliac spines, will furnish the angle of abduction or adduction by means of Lovett's table (see p. 262).

The patient is now asked to flex both limbs right up. The movement is compared and the hips are then tested in turn for flexion deformity (Figs 6 and 7).

The sound leg is examined first, and put slowly and gently through its movements. The good knee and hip having been flexed until with the thigh pressed on to the abdomen all lumbar lordosis is obliterated (but no farther, or the pelvis itself will be flexed on the spine). This position is then carefully held and the child is asked to lay his other leg flat on the table. If he attempts to do so and cannot, or if he does not try and gentle assistance is resisted, one has a positive answer to the 'flexion deformity test', 'which indicates the slightest commencement of hip joint malaise'.¹

The affected limb is next held very steadily by the knee, and movements

¹ H. O. Thomas *An Argument with the Censor*, p. 9

are attempted very slowly and so gently and tentatively that, however sensitive the hip may be, it is not hurt. If the pelvis moves with the thigh flexion is stopped as soon as all the lordosis is lost and the patient is asked to put the good leg on the table for comparison. Thus he can do, showing that in this hip there is no flexion deformity.

Then the examiner, standing at the foot of the couch and taking one foot in each hand, gently rotates both limbs, watching the whole pelvis and comparing the range of external rotation and internal rotation on the two sides. Abduction is then tested, the examiner asking and assisting the child to



FIG 6 Flexion deformity demonstrated



FIG 7 No flexion deformity

separate his legs as widely as he can while he watches the anterior superior spines closely for tilting. If there is arthritis of one hip all its movements will be limited by muscular resistance, being less free and full than those of the other hip. It is not always possible to demonstrate this in regard to rotation, but whatever loss there is will be balanced; therefore an unbalanced loss, say of internal rotation, is suggestive of another diagnosis, probably adolescent *coxa vara* or, very rarely, of adhesions in the *gluteus maximus*. Similarly, a flexion deformity with free rotation may be the result of psoas spasm due to a subacute appendicitis or to osteitis of a lumbar body or transverse process. No attempt should be made to overpower the resistance at the limits of movement. The whole of the examination can be made without causing any pain, and even without inducing any movement of the joint if the disease is active and the sensitive hip fixed by muscular spasm. To force movement is harmful, and examination under anaesthesia is useless and dangerous. The symptoms and signs described are characteristic of tuberculous disease of the hip, but they are not in any sense pathognomonic. The signs and symptoms show that something is irritating the hip and causing an arthritis which is like that due to tuberculosis, but nothing more. It may be, as we shall see, due to other causes, but the important thing is that the patient should be promptly

admitted to an orthopaedic hospital on a '*provisional*' diagnosis of 'Observation Hip', to start treatment and await exact diagnosis. Expert radiography is an immediate need, but *negative radiographs do not exclude tuberculosis*. This can hardly be repeated too often!

Lump and limitation of movement in all directions by muscular spasm are reliable proofs of arthritis of the hip. Nevertheless, their absence does not exclude an endosteal focus without infection of the joint. One should bear this in mind when the general condition of the patient is suggestive of tuberculosis and pain is felt in the region of the hip. Under such circumstances insist upon obtaining very good stereoscopic radiographs, then study them very carefully for small endosteal foci are elusive! If such foci remain unrecognized the disease may spread and infect the hip, but this catastrophe can probably be prevented in some of such cases by the discovery and eradication of the focus by an extra articular route.

Confirmation of diagnosis.

The patient has now been admitted with arthritis and it remains to distinguish tuberculosis from other sources of inflammation. For this we have more and more come to rely upon radiography. A radiograph will often settle the diagnosis straight away, at other times a series taken at suitable intervals will do so. The radiograph will, as a rule, include both hips for comparison, and in some cases be stereoscopic in order to demonstrate endosteal foci or slight antero posterior displacements of the femoral head. The characteristic effect of tuberculosis is a localized fading of the bone shadow, a similar fading occurs with disuse, but is more diffuse.

Radiographs.

Localized erosion without reaction (Fig 8) is characteristic of tuberculosis, and the picture is different from the clearly defined lesions of syphilis (Fig 9) and the necrosis or proliferation associated with septic infection (Figs 10a and 10b). During the early period of evolution, *the X ray evidence lags far behind the actual extent of pre erosion invasion of the bone*. Bone infiltrated and rotten with tuberculosis when seen by the surgeon's eye or felt by his finger, may have appeared of normal structure (though relatively decalcified) in recent radiographs (see p 6).

Skin tests.

In all cases a Mantoux intradermal test is carried out. Negative tests at all ages are valuable, positive only in young children, but in a very ill patient with rapidly progressive disease a negative skin reaction does not exclude tuberculosis.

Blood tests.

A Wassermann test should be undertaken in all cases or at least whenever there is anything suggestive of syphilis. A differential blood count is useful when the diagnosis lies between tuberculous and pyogenic osteitis, the former

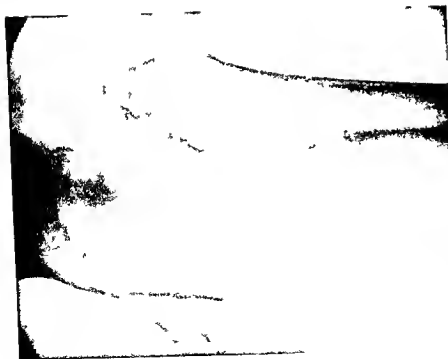


FIG. 8 The decalcification and erosion of tuberculosis



FIG. 9 The destruction, proliferation, and sclerosis of syphilis. Note lipping of acetabulum and sclerosis of round focus. Distinguished from tuberculosis by radiograph and Wassermann reaction



FIG. 10a. The sclerosis of head and metaphysis of femur associated with sepsis.

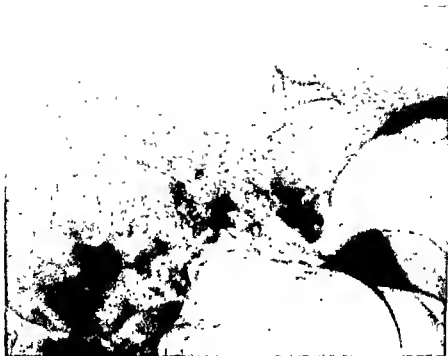


FIG. 10b. The widespread and irregular destruction and reaction associated with osteomyelitis of the ilium affecting the hip joint.

producing a relative increase in lymphocytes, the latter in polymorphonuclear cells. Furthermore, if pus is available by aspiration it should be fully examined.

DIFFERENTIAL DIAGNOSIS

Quite often diagnosis remains in doubt, and then our procedure differs in children and adults. In children treatment is carried on for a further period as if the hip were tuberculous, under the provisional diagnosis of 'Observation Hip'. But in adults the differential diagnosis is less difficult and time is more valuable, therefore whenever the history is characteristically insidious, the whole picture that of subacute or chronic monarticular arthritis, and two or three serial radiographs show progressive decalcification with early signs of erosion it is unnecessary to wait long before proceeding to arthroscopy.

1. Transient arthritis of the hip.

This is a clinical term applied to an arthritis or synovitis which responds to treatment in a few days or weeks. It is probably usually due to streptococcal infection from the pharynx or intestine. All patients with 'observation hips' are put at once on some form of immobilization—in the author's present practice, on a Robert Jones double hip frame (see p. 251).

The distinction between tuberculosis and 'transient' arthritis is made by clinical progress after the search for and elimination of likely sources of streptococcal infection. Transient arthritis is suggested by the persistent absence of radiographic changes other than those of the decalcification of disuse associated with a non-destructive arthritis. When this is so after immobilization on the frame for a period estimated on clinical grounds and varying from a fortnight to six or eight weeks, the patient is taken off the frame and examined. If the hip feels promising, if the movements are free within limits and not associated with muscular resistance, the patient is set free in bed. In two or three days, and again in a week, the movements are examined. If the joint is still 'sticky' and there is muscular resistance, he is put back on his frame as an 'observation hip' for six to eight weeks and then put through the test again. But if, on the other hand, the movements were gaining freedom during the first week, they are tested once more after another week's freedom in bed, if there is progress the patient is allowed up in the ward, and if all goes well for another week he can go home.

2. Osteochondritis of the femoral head (pseudocoxalgia).¹ Age-incidence 6-12

This is an ischaemic disturbance of the epiphysis which, if untreated, leads to a flattened head and a thickened neck, producing in fact a coxa plana (Fig. 11). If, however, the condition is recognized early the hip must be immobilized until the period of reaction is over, and the head must be protected from compression during the long period of disorganization and feeble growth. Actually this takes several years (Fig. 12). Of these, the first should be

¹ Platt *British Journal of Surgery*, 9, 366



FIG 11 A fairly early case of pseudo-tumour of the hip joint



FIG 12 A case of pseudo-tumour of the hip joint treated by protection from weight bearing over a period of 2 years

spent in bed but later on the patient may be allowed up if one can rely on unremitting protection of the head by an exactly fitted weight bearing caliper. The affected neck will always be thicker than the normal but the spherical form of the head can be restored and this is a very great achievement for the distorted femoral head of untreated or imperfectly treated pseudo coxalgia inevitably leads to the onset of osteoarthritis in middle life (Fig 13)



FIG 13 A distorted hip of untreated pseudo coxalgia

The lesion is non erosive—bone suffers cartilage does not. The bone cells suffer death or suspended animation but the cells deep in the hyaline cartilage find sufficient nourishment to maintain their existence and multiply. The children always recover with a mobile hip. In the past pseudo coxalgia as its name implies was mistaken for true hip disease and the end results so much better than those of tuberculosis misled the profession and falsified statistics.

Very rarely tuberculous hip disease starts in the semblance of Perthes disease ischaemia of the epiphysis results from a tuberculous embolus of the artery in the ligamentum teres. This is truly a wolf in sheep's clothing and the deception calls for early exposure if only on account of the very



Fig 14 Radiograph showing a lesion involving the head of the left femur with relative hypercalcification compared to the right. Ultimately this was replaced by the decalcification and erosion of tubercle

different evolution of the two conditions. The general condition may be significant, but the disguise is unlikely to be detected unless serial radiographs are closely examined. The X ray indications are at first those of ischaemia (see Fig 14) and therefore completely deceptive because contrary to those of tuberculosis, but in the course of three or four months they begin to show unmistakable evidence of erosion and decalcification.

3. Osteochondritis dissecans. Age incidence 10-20

This is commonly the result of a vascular accident or minor injury. One of two things happens: either a flake of articular cartilage and underlying bone is separated by the injury and floated off its vascular bony bed by the subsequent haematoma, or, alternatively, some small vessel, an end artery, is thrombosed or embolized, with the result that a small island of bone and cartilage is separated by aseptic necrosis. In either case the movement of the joint may prevent the re-establishment of vascular connexions, and the fragment, remaining necrotic, gradually gets looser in its bed until it becomes a loose body. The partially detached stage is particularly likely to set up irritation which may well arouse a suspicion of tuberculosis, but a radiograph will ordinarily settle the diagnosis. Fig 15 represents a radiographic appearance which is characteristic of osteochondritis dissecans. But in this particular instance the condition was caused, presumably, by a tuberculous embolus, for subsequent pictures show that this condition, which began with a vascular accident, has gone on to typical tuberculosis of the joint (Fig 16). One must remember, then, that both a central osteochondritis of the head, as in Perthes' disease, and, even more rarely, a superficial detachment as in osteochondritis dissecans, may be due to an arterial tuberculous infection. The lesson to be learnt is that a diagnosis on one radiograph should be regarded as provisional until it has been reviewed in the light of subsequent evidence.

4. Adolescent coxa vara. Age incidence 11-17

This is a traumatic displacement or gradual slipping of the head of the femur downwards and backwards off the neck (Figs 17 and 18), the latter follows a disorganization of the epiphyseal disk, and its osseous relations, the cause of which may be vascular, infective, or an endocrine imbalance. There is at first a reaction of the joint which may easily be mistaken for tuberculosis unless the X ray examination is thorough (see case B U, p 70). It has recently been demonstrated¹ that lateral radiographs show the displacement of the head much more clearly than antero-posterior views. The displacement of the head relative to the neck is downwards and backwards, and at first more backwards than downwards.

¹ P D Wilson *J Bone and Joint Surg* Vol XX, April, 1938, p 379 and *Surg Clin North America*, XVI, 733, 1938

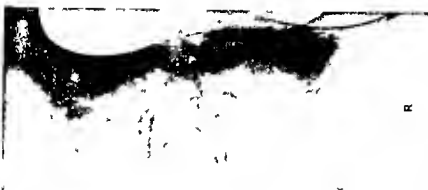


Fig 15 Typical picture of osteochloritis dissecans

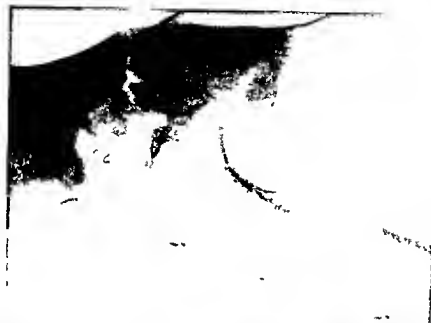


Fig 16 The erosive decalcifying arthritis which was proved to be tuberculous

5. Syphilis.

When suggested by the family or personal history the X ray picture, or any significant signs or symptoms a Wassermann test should be done a positive reaction will prove syphilitic infection, but a negative is by no means decisive Again the responsibility of syphilis for the arthritis must be confirmed by the favourable effect of antisyphilitic treatment For a positive Wassermann reaction does not exclude tuberculosis, especially when it is remembered that syphilitic hip disease is rare, possibly more rare than tuberculous hip disease in patients infected with syphilis In the author's experience, which covers many adults as well as children, neither syphilitic hip disease nor combined syphilis and tuberculosis is as common as has been supposed A positive Wassermann or Sigma reaction has been returned in less than 4 per cent of the cases tested¹ Actually in adults a syphilitic hip is more likely to be taken for osteoarthritis than tuberculosis There are several forms of syphilitic joints

(a) *Congenital.* (i) '*Epiphysitis*' Age incidence 0 to 5 Commonly associated with displacement of the epiphysis causing deformity and 'pseudo paralysis', both being due to the displacement It occurs most often in the shoulder The appearance and radiographs are characteristic, and the whole picture is different from the synovial tuberculosis of young children It is treated by reduction of the displacement, splintage, and standard anti syphilitic measures

(ii) *Synovial arthritis* Age incidence 7-12 Commonly associated with some synovial thickening and much fluid In congenital syphilis this type is commonly symmetrical, but not otherwise polyarticular

(b) *Acquired.*

During the secondary stage some slight synovitis has occasionally been observed, apparently due to synovial or perisynovial infection

The characteristic tertiary arthritis of adults is associated with *gummata* of the perisynovial tissues, or, less often, of the bone ends Any of the larger joints may be affected, most often the knees The areas of bone destruction are more clear cut and demonstrable than those in tuberculosis There may be periosteal thickening toward the articular ends of the bone The condition is usually accompanied by *pain* which is often worse at night

Syphilis may be distinguished from tuberculosis by the history, by other syphilitic manifestations or scars by the characteristic night pain, and, when tertiary, by the nodular irregularity of the perisynovial swelling, and, in some cases, by the characteristic radiograph The diagnosis is confirmed by the Wassermann test and by the effect of treatment

¹ And the tests were on cases selected because they were in some way suggestive of syphilis, in 100 unselected cases at the Royal National Orthopaedic Hospital, Stanmore, there was only 1 positive



FIG 17

FIGS 17 and 18 Boy aged 14 Adiposo genital type Began to limp on his left leg in September 1938

On the X ray pictures from the 5th November 1937 on comparison of the two hips, a small displacement is seen in the lateral view The displacement is seen as an epiphyseal hook downwards The anterior view appears normal except that the epiphyseal line is somewhat broader than on the sound side Thus in early cases it is sometimes impossible to see the displacement of the epiphysis in an anterior view (By courtesy of Prof Waldenström)

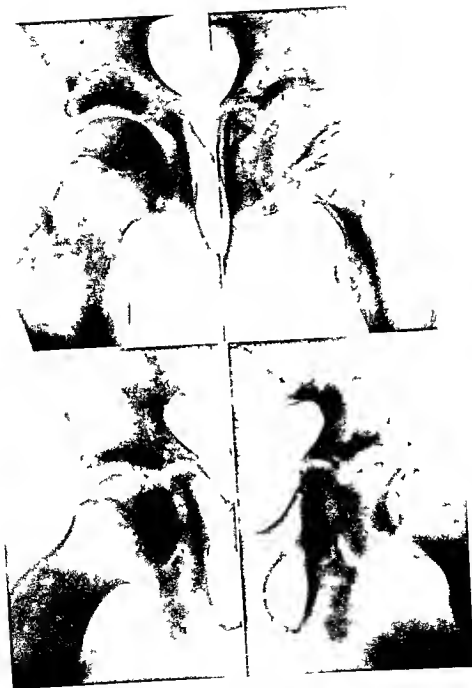


FIG 18

6 Haemophilia.

Haemophilia leads to swelling from effusion of blood into the joint and the synovial membrane. Relapses occur, and the synovial membrane becomes thickened and the joint movement limited by adhesions. There is also sometimes periosteal new bone laid down as a result of subperiosteal haemorrhages round the articulations (Fig. 19). The knee is much the most commonly affected joint. Diagnosis by history, clinical and radiographic examination, never by arthrotomy!

7. Acute infections of the hip

(a) **Acute pyaemic arthritis** This is fairly commonly associated with streptococcal or staphylococcal infection and occurs occasionally in gonococcal pneumococcal or epidemic infective disease. There is a rare form of acute pyogenic arthritis in infants often associated with pathological dislocation and necrosis of the femoral head. This is sometimes called Barlow's disease. The onset is sudden, with high fever, illness, local tenderness, and immobility of the limb. This last may be so marked a feature as to lead to a diagnosis of infantile paralysis. But the localization of tenderness and resistance to movement indicate arthritis. Immediate immobilization and repeated aspiration should be tried, but drainage is almost always necessary. In this and in acute arthritis the rapid onset, acute tenderness, and, above all, the evidence obtained by aspiration distinguish the condition from tuberculosis.

In children or adults a septicaemic infection of a joint commences in exactly the same way as the bacillaemic infection of tuberculosis. It is commoner in children, again, as in tuberculosis, on account of the end arteries and lack of anastomosis in areas of bone surrounded by avascular cartilage. Although the method of infection is the same, the reaction is remarkably different. There is a rapid onset, pain, high fever, severe illness, with the most acute tenderness of the joint. A child with such a condition is terrified at the approach of a doctor for fear of any handling of the limb or movement of the joint. The indication for aspiration both for diagnosis and treatment is pressing. Furthermore, if turbid fluid or pus is found and a pyogenic infection recognized by the bacteriologist, the joint should be immobilized and aspiration repeated daily under gas, synovial fluid is at first bactericidal but when stale forms an excellent culture medium, and tension within the joint leads to rupture of its walls and spreading infection of the intermuscular planes. This calls for the most radical measures, even amputation as a life saving procedure.

(b) **Gonococcal arthritis** There are several types, from the acute nonarticular pyogenic arthritis, usually of a big joint, associated with active gonorrhoea, to the chronic polyarticular arthritis which develops much later in the disease and resembles rheumatoid arthritis in that the swelling is mainly periarticular. The former is as locally destructive, though not as

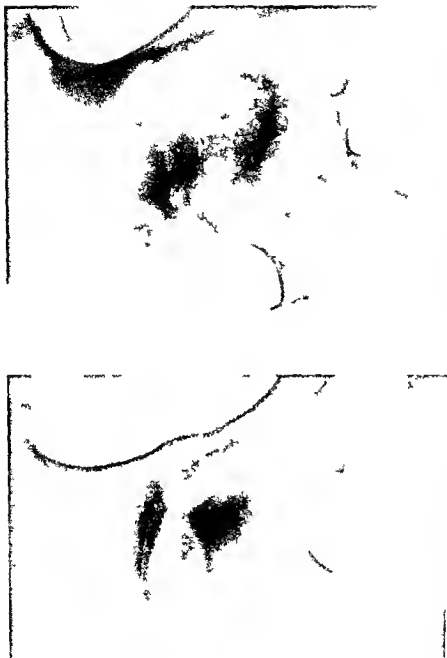


FIG 19 Distal femoral fracture with associated repeated haemorrhage (haemophilic)

FIG 20 Pyogenic arthritis of the hip. Absorption of articular cartilage on an infection of bone

threatening to life, as pyogenic staphylococcal or streptococcal arthritis, the articular cartilage is quickly dissolved and ankylosis usually results. Neither this type nor the rheumatoid is likely to be mistaken for tuberculosis, the gonococcal fixation test is of value.

(c) **Rheumatic arthritis.** This, too, is much more acute than tuberculosis and almost always polyarticular and shifting. It is very unlikely to be mistaken for tuberculosis. On the other hand, acute pyogenic arthritis may be mistaken for acute rheumatoid arthritis with disastrous results.

(d) **Periarticular osteitis.** As in tuberculosis, a pyogenic infection may be deposited in a bone and spread to the joint. Early recognition by pain, fever and localized tenderness, and extra articular drainage, will save the joint much more often than in tuberculosis. If the lesion is subacute, radiography will play a valuable part in diagnosis. In later stages the evidence of necrosis with a localized sequestrum, which appears hypercalcified in relation to the surrounding bone, suggests pyogenic infection rather than tuberculosis. The sequestra are commonly a part or the whole of the head, whereas in tuberculosis sequestra are more commonly seen in the juxta epiphyseal region of the neck. In pyogenic infection there is osteogenesis in a few days and sclerosis later (see Fig 20), in tuberculosis subperiosteal new bone formation is rare and relatively faint, and the sclerosis appears, if at all, a year or two later.

8 Rheumatoid arthritis. Age incidence is commonly 20-35 years

We are concerned with this condition in its monarticular stage, i.e. with the first joint affected. This is most commonly the knee, occasionally the hip, the wrist, or the ankle. As a rule, the type of patient and the radiographic picture make one suspicious of its non tuberculous character (see Fig 21).

If this begins in the knee, or the hip, and there are no other manifestations for a time, it is easily mistaken for synovial tuberculosis. It should be treated under provisional diagnosis until a decision is reached either by means of a diagnostic operation or in the light of the clinical progress.

9. Osteoarthritis (Fig 22) Age incidence is commonly over 30

Senile tuberculosis is sufficiently rare to be easily forgotten, while 'osteoarthritis' is common. In truth, it is long odds against tuberculosis being the cause of a painful hip in an elderly man, but one cannot be too careful, for patients resent the appearance of an abscess containing tubercle bacilli in the region of the hip which they have been told is osteoarthritic, and for which they have had long continued and expensive medical treatment. The distinctive signs in tuberculosis are as follows: there is limitation by muscular spasm, and in the elderly generally a complete muscular fixation, and the hip is silent, whereas in advanced osteoarthritis there is some movement, characteristically that of straightforward flexion and extension with rotation or abduction, and there is often an audible creak or grate as of bone on bone at a certain angle or angles. The radiograph of



FIG 21 Rheumatoid arthritis Absorption of articular cartilage and some general decalcification no bone erosion or reaction



FIG 22 Osteoarthritis Some absorption of articular cartilage no local decalcification clearly marked bone outlines with lipping An early case

tuberculosis shows erosion and decalcification irrespective of weight bearing whereas in arthritis there is disappearance of articular cartilage and the approximation of bone to bone at the weight bearing area with surrounding flaring or mushrooming of the head and an absence of decalcification



FIG. 23 Spondylitis Rhizomelique. Evident process of ankylosis

10 The ankylosing arthritis of the hip associated with Spondylitis Rhizomelique (see Fig. 23) Age incidence is 15-30 Sex—male

Sometimes the earliest indications of this disease are pain and limitation of movement in one hip which at first sight suggest tuberculosis (Fig. 24). A failure to make the distinction is all the more unfortunate in that the patient may find to his extreme annoyance after prolonged treatment on a frame for tuberculosis of one hip that his spine and both hips are ankylosed!

The appearance of these patients is as a rule rather characteristic: thin, sallow, and dark haired. Though this appearance is toxic, it is usually quite different from that of tuberculosis. Skilagrams show that the articular cartilage is being destroyed rather than the bone. It is as if the articular cartilage with its underlying bony shell is being uniformly dissolved. Actually it is this solution which prepares the way for the rather rapid and solid

ankylosis As a rule, the sacro iliac joints are attacked quite insidiously without pain before any other joint and radiographic examination of the sacro iliac joints indicate a remarkably symmetrical replacement of the



Fig 24 Spondylitis Rhizomelique Absorption of cartilage but no specific changes in the appearance of the bones If there is decalcification it is purely that of disuse The internal trabeculation is evidently unaffected

sacro iliac cartilage space by bone with the areas affected spotted or patchy This is most distinctive and valuable evidence (see Fig 25)

11. Neoplasms

The symptoms and clinical signs of a sarcoma or a secondary carcinoma may closely simulate those of tuberculosis Fortunately they can almost always be distinguished from tuberculosis by radiographs though a massive pyogenic osteitis of the ilium may look exactly like a sarcoma A benign growth or cyst is usually far more clear cut out of normal bone than a tuberculous focus but may be, as Fig 26 illustrates, a very deceptive lesion

12 Hysteria.

Here the appearance of the patient the history of onset the reaction to examination, and the other familiar signs of hysteria are likely to point to the correct diagnosis. The X ray appearances are normal. At the same time difficulty may arise and the distinction may become one of clinical judgement.

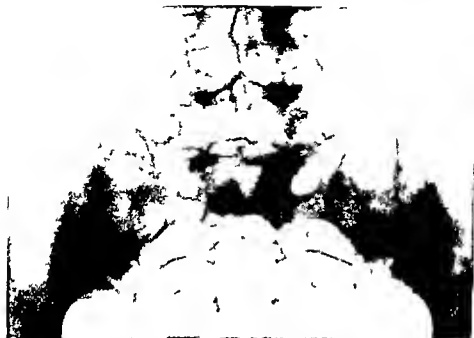


FIG. 25 Spondylitis Rhizomelique. The characteristic ankylosing arthritis of the sacro iliac joints. The articular cartilage disappears and is replaced by bone which is at first unevenly calcified.

and negative radiographs. It is, however, important to remember that examination under an anaesthetic is only justifiable if radiographs are normal and the clinical signs of tuberculosis absent.

13 Various

Not long ago the author saw a patient with a very painful left hip. The signs of arthritis were present but history and examination suggested and radiographs confirmed the existence of old unreduced congenital dislocation of the hip. It was rather naturally assumed that the condition was arthritis due to mechanical overstrain but at operation tuberculous pus was found in and round the hip joint!

TREATMENT

General

This is standard. For in every case of tuberculosis of the hip in a child we must assume a persistent active and dangerous tuberculosis of the lymph

glands. With rare exceptions this is equally true for adults and unhappily, with far graver significance. The exceptions are those with a very long history perhaps twenty years or more, of pain and strain, in whom mechanical strain on an unsoundly healed joint lesion has kept up grumbling disease long after the primary lymphatic tuberculosis has finally healed. In these cases we have the visible lesion alone to consider, with its eradication or healing they are cured.



FIG. 26 Malignant disease in a woman of 59. The condition simulated tuberculosis in history and all signs and symptoms. Distinguished by radiograph. The patient died with multiple metastases within three months.

The aim of general treatment is the complete and permanent recovery of the patient as a whole, and this general treatment should be carried out in an open air hospital, with sun and air skilfully applied summer and winter, for at least a year in every case irrespective of what is done for the joint. In children the hospitalization of hip disease is likely to last three years or longer. Afterwards and thus after care is even more important (and more difficult) in adults than in children, the patient must live under really good conditions for several years. This does not in the least mean that the child cannot go to school or the man to work. Mention has already been made of the value of occupation for the mind, and the hands, of all the patients while in

hospital, indeed, no time should be lost before directing a man's mind toward some new vocation, when his old is obviously unsuitable, and preparing him for it as far as possible

Local.

On admission the patient is ill and, though perhaps imperceptibly, going down hill, the bacilli are multiplying, the tuberculous infiltration of the cancellous bone is advancing, and the sensitive joint is 'guarded' by the spasm of its wasting muscles. But the protection of muscular spasm is far less effective than splintage, for one thing, the spasm itself increases the pressure on the weakened bone and softened cartilage, for another, the pull is unbalanced and deformity results, and in sleep the slackening of the muscular control allows movement. Nature's cure of hip disease leaves a flexed, adducted, shortened, and wasted limb

In a few weeks, as a result of rest, comfort, and good food, obvious illness disappears, pain, fear of movement, muscular spasm, deformity, and destruction are checked by perfect immobilization, and the wasting of bone and muscle is lessened by the unrestricted circulation, and by the effect of the sun and the wind on the skin. Complete physical rest is the essential foundation of treatment throughout this stage, and 'ambulatory' splintage is utterly wrong.

The hip is an elusive joint, with a socket set deep in the pelvis, allowing movement in every direction and 'controlled by the strongest muscles of the body', a part notoriously difficult to splint. Thomas taught us to avoid all risk of constricting the circulation, and that rest included relief from pressure in the joint as well as from movement, whilst experience teaches us that it is wise to keep the pelvis under daily observation. The joint is sensitive and the muscles are irritable but it is essential that the parts should be kept in the chosen posture, controlled but uncompressed. Fixed extension on a well padded frame fulfils these aims.

Splintage

The splint must be comfortable, with a smooth clean surface, for it is to be semi permanent in the sense that from month to month there should be no movement involved by nursing, no lifting of body or limbs, no washing of the parts that cannot be reached without disturbance. The whole trunk must be straight and square with the pelvis, and the splint must enable us to place the affected limb in the position of choice. It is also desirable that the splint should be cheap, simple, of a standard pattern, and easy for nursing.

For the sake of simplicity, only one type of frame will be described in this book, the principles can be applied to any other (see p 126)

On the frame the body itself must always be straight, and every day the patient's nurse must assure herself that the anterior superior spines of the ilia are exactly level. If this is not done it is only too likely that scoliosis will

result. With the body, then, perfectly true on the frame the limb can be placed, and permanently held, in the exact position of choice. This position varies somewhat according to the age of the patient and the prospects of the joint.

Whenever mobility is our aim, we obey the rule for the posture of any joint where movement is expected, and put the limb, not in the anatomical position, but rather toward that which is difficult to attain after immobilization, whether the difficulty is due to weak and overbalanced muscles or to leverage and gravity.

The Primary position of splintage. For the hip the standard position is

- 1 Abduction of about 30°
- 2 Flexion of about 3°
- 3 Rotation nil

The prospect of ankylosis must be accompanied by a change in the position of splintage from the Primary to the Final.

The Final position. The optimum position for final ankylosis is

- 1 Abduction $0-5^{\circ}$
- 2 Rotation, slight external, $5-10^{\circ}$

This external rotation in ankylosis is advantageous in order that when the patient swings his pelvis round to take a step forward the foot shall point forwards rather than a little inwards.

- 3 Flexion, up to 10 years, 10° , 15 years, 15° , 20 years 25° , 30 years, $30-35^{\circ}$, or, say, a degree for each year of the age up to 20, then a little more.

Figs 27 and 28 and Figs 29 and 30 are photographs of two cases with fixed hips illustrating the effect of the different angles of flexion. For adults, 30° to 35° is probably the wisest compromise between the best position for standing or walking and the best for sitting. The flexion angle varies with the age because during childhood the lumbar spine can develop unusual mobility and so allow the patient to sit comfortably with hip only slightly flexed, but later in life the spine is not nearly so adaptable, though what it has learnt in youth it will keep for many years. The patient's occupation must also be remembered, and where much sitting is expected with little standing or walking a degree of flexion up to 45° may be desirable, an angle which is right for the sempstress is wrong for the station master.

There is another difficulty, for the muscles of a joint, once free movement has been lost, no longer work in balance. As a result of this unbalanced force the position of the joint alters unperceptibly during the process of ankylosis, and even after the most solid ankylosis if the epiphyseal cartilage is intact and growing. The position desired for final ankylosis is known, what allowances are to be made? For the present discussion it is assumed that operative arthrodesis is not in view. Without arthrodesis it will inevitably be years before the joint has settled soundly into its final position,

and once the dominant *immobilization* of the frame is changed for less effective splintage the overpowering pull of the flexors and adductors will insidiously deform the joint



FIG 27



FIG 28

FIGS 27 and 28 Girl aged 16 Flexion angle 32° She stands with considerable lordosis but sits easily



FIG 29



FIG 30

FIGS 29 and 30 Boy aged 17 Flexion angle 11° He stands easily but sits with difficulty

It is wise then to pose the joint without rotation and with more abduction and less flexion than that required in the end. In young children we should anticipate and allow for very gradual adduction and flexion beginning after the full control of the frame has been lost. The younger the patient

the wider should be the abduction, for sound fixation is attained so much more slowly. The bearing of extra articular arthrodesis will be discussed later.

We have, then, a standard treatment for the active stage

- 1 For the body as a whole, the prompt application of physical rest and physiological stimulation and
- 2 For the hip, fixed extension and unremitted immobilization in a chosen position

In children (except in those rare instances when radiographs show a metaphyseal focus which is clearly extra articular) there is no indication at an early stage for operation, whether directed towards diagnosis, towards eradication of the disease, or the attainment of ankylosis. But in adults the problem is altered owing to the difference in the patient's power of reaction to or recovery from the disease. Furthermore, the time factor is different: children can spare a long time if it is in their best interest, as undoubtedly it is, adults seldom have unlimited time, nor do they benefit from prolonged splintage in bed (rather the reverse). For adults then, there is a definite advantage in a relatively early diagnosis, and in operative arthrodesis with or without thorough eradication of the disease.

Correction of deformity.

When a patient reaches hospital in the active stage of the disease there is always some flexion deformity.

Radiographs will show whether this is due solely or mainly to muscular spasm, or associated with advanced destruction of bone.

1 If the deformity is purely muscular most of it can be corrected with one steady slow movement, carried out without an anaesthetic, as the final act of applying the frame. *This movement must be followed always and instantly by complete immobilization.* Some lordosis will persist for a day or two, until the flexion of the hip is fully lost.

2 But if the case reaches hospital later, and radiographs, while showing that the deformity is associated with bone destruction, yet do not suggest organized fixation, the patient should be anaesthetized and put on the frame. During the whole of the procedure the hip must be most carefully 'held', for the anaesthetic will have thrown its muscles off their guard. When all is ready the surgeon tries to reduce the deformity, slowly, steadily, in the way just described, without wrench or jar.

If gentle pressure fails to correct the deformity, or if the radiographs indicate commencing organization, it is best to immobilize the joint with fixed traction, adjusting the limb at an angle rather more obtuse than that of the flexion, so as to induce considerable lordosis. It will generally prove possible to improve the position from time to time as the traction and immobility relieve the muscular spasm and lessen the infiltration. Lordosis will diminish and the angle of the frame can be progressively altered.

At a still later stage, if the organization has advanced towards healing and

there is fixed adduction as well as flexion correction cannot be carried out by conservative means. Such a case no longer belongs to the first stage but to the second stage (ankylosis group). It will be put in plaster without altering the deformity until correction by osteotomy is safe.

Cases of deformity seen only when healing is complete will be considered later.



FIG. 31. Case M.C. Grumbling disease. X-ray showing persistent instability of the hip with extreme destruction as a result of chronic persistent disease, seldom very active over a period of 40 years.

Second stage

While the first stage is associated with active disease and the third with the signs of healing, the second is transitional. By this time the patient has responded to treatment: pallor has gone, fever is over, his body is revitalized and resistant, necrosis and decalcification are now at a standstill, the joint and its muscles are no longer irritable.

It is necessary to note the signs which indicate the beginning of the second stage. A time period is helpful, yet, as there are many variable factors, it cannot be precise since it must be related to the clinical progress in each case. So long as the patient remains feverish, ill, and is losing weight, it would be futile to begin to count the weeks. The beginning of the second stage may be put at three months after all the following conditions have been fulfilled:

1. Fever, if present, has disappeared
2. Progressive loss of weight has changed to gain
3. An aspect of illness has changed to one of health

At the end of this three month period, which may be four, eight, or even twelve months from admission, the joint will no longer be tender or swollen.

This then, is the beginning of the second stage. Up to the present, every effort has been concentrated on the improvement of general health and vitality and the checking of inflammation in the joint. At this point, however, we must, so far as children are concerned, face a critical decision, and, to settle it wisely, we must review and sum up every aspect of the case, taking into account age, health, social conditions, employment (or prospective employment), and the amount of damage done to the joint. *This question does not arise in adults, in whom a hip joint proved to be tuberculous is only safe when ankylosed or amputated.*

Are we to aim at a movable or a fixed hip? This question is to be answered for each child in strict relation to our standard, 'a permanently safe and useful limb' (Lovett). Having come to a decision, we must at once take steps to achieve one or other aim, and these steps diverge in that the treatment favourable to mobility is unfavourable to fixation, and vice versa. Both these aims are legitimate, but it is easy to fall between two stools and end with either movement that is not free enough in its range, and firm at its limits, to be safe, or fixation that is not massive enough to resist strain. For if the movement is not quite free over its whole range (whatever that may be) a sudden jar may overcome the muscles and rupture the granuloma. Tubercle bacilli may thus be set free in damaged tissues—a state of affairs likely to lead to recrudescence of the disease.

Sometimes this happens again and again. Figs 31 and 32 illustrate typical examples of this insecure healing with persistent recurrence over a long period of years.

So, too, ankylosis, whether involving the whole or only part of the coapted



FIG. 32. Persistent grumbling disease associated with pain and severe flexion, adduction and rotation deformity present for many years. (Ex Robert Jones Birthday Volume.)

surfaces, is never safe until it is sound, for unsoundness means that the bone or fibrous tissue forming the union is immature or still inflamed, and therefore unfit to stand the wear and tear of use

A partial ankylosis, however sound, may not for a time be massive enough to resist a shock. For such conditions extra articular arthrodesis provides a happy solution

If, then, the joint surfaces do not appear much damaged or deformed, as shown in the radiograph, and this is borne out by free movement through the

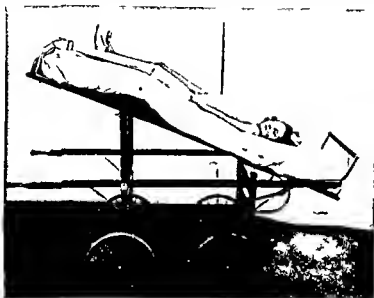


FIG 33 Carshalton Extension

very small range, which is all that one tries at this stage, *mobility* can be our aim. But in some cases the issue is not clear, the prospects of mobility are still uncertain, and the final decision has to be held over for a *test period* of weight extension, e.g. 'Carshalton or Marsh' (Fig 33). If the movement of the joint gets freer week by week, we may safely go on with the weight and pulley, aiming at a mobile joint. We aim at mobility so long as there is good hope of getting movement sufficiently well supported at its limits to be safe. *We aim at ankylosis only when radiographs or tests tell us that without ankylosis the limb is unlikely to become permanently safe and useful.*

It is well to remember the unique difficulties of the hip. The erect position has its drawbacks, for our weight bearing joints are prone to osteoarthritis. The hip is affected most often and most painfully. While at every step the knee and ankle have to carry the weight of the body, the hip labours under so great a mechanical disadvantage that it must bear twice that burden. It is small wonder that this overworked joint, even when perfectly formed by Nature, is a common seat of osteoarthritis. Secondary arthritis is still more common, ultimately inevitable, after arthroplasty when the bone ends have been

imperfectly reshaped and relined by the surgeon, or have suffered in form though not in lining by *cova vara* and *pseudocoxalgia*. How poor, then, must be the ultimate prospect for a joint when the articulating parts are deformed by the erosion of tuberculous disease. Natural healing is seldom of a sort which will make the best of a bad job and the surgeon often feels called upon to interfere. In making his plans he should remember that sound fixation is better in the long run than a semi mobile but ill fitting weight bearing joint. At the same time he will recognize degrees of damage and must decide when it is safe and right to aim at mobility and when such a course will leave the hip prone to a recurrence of tuberculosis or an early onset of disabling osteoarthritis.

The aim is mobility.

Experience has taught us that this is never a sound policy in adults and only in a minority of children. In these the surgeon will rightly avoid a premature decision: therefore, whenever there seems a reasonable hope of ultimate mobility he will immobilize by some form of traction splintage in decubitus during the second stage. 'More haste less speed' should be our guide. The earlier, longer, and better the immobilization the better is the prospect of movement.

In every case, then, in which there is radiographic evidence of destruction of the articular surface of the femoral head or the acetabulum, the possibility of attaining a useful, permanently safe, and painless range of movement must be reviewed from time to time. If, after recalcification, there is good ground for hesitation it is probable that arthrodesis will be the best policy. Fortunately a hip arthrodesed in childhood is wonderfully serviceable and not very noticeable. And nowadays the surgeon gleaming the fruit of much experience of operative arthrodesis in many clinics will have little difficulty in making sure of sound ankylosis in good position. The indications for, and technique of, arthrodesis will be considered later.

The aim is ankylosis.

Here one must consider children and adults separately. *In children*, so the author believes, it is always best to carry on with treatment on a frame until the general condition has been very good for many months, and X rays show evidence of healing by recalcification and better definition of outlines. This is the time for a decision for or against arthrodesis and, if the latter is to be carried out, for a choice of the technique which will be most suitable. Often extra articular arthrodesis alone will suffice. But where there is a mass of debris (see Fig. 34), showing no sign of consolidation, and separating what is left of the femoral head and neck from the ilium, it may be advisable to excise first, and only at a second session to carry out extra articular arthrodesis.

In performing extra articular arthrodesis the author believes very strongly in the advantage of *operating on the patient lying undisturbed on the frame, or*

through a window in the plaster and such is his practice For this imposes no strain on the infected granulation tissue and who can tell how securely it is healed? After the operation the patient remains on the frame until X rays show that he can be got up in plaster The plaster is retained until the synostosis is sound The greatest care must be taken to avoid any movement while the plaster is being changed

The author has recommended operative arthrodesis as an almost routine



FIG. 34 The femur and weight bearing of the ilium are separated by a transparent area representing a mass of lebris, sloughed cartilage, perhaps pus, and granuloma sufficient to render any extra articular arthrodesis unstable

treatment But all are not agreed as to the advisability of this course and there can be no doubt that it is only advisable with expert surgery in a first class orthopaedic hospital The surgeon should be prepared to overcome technical difficulties in order to maintain the splintage undisturbed

It will be noted later that in regard to most tuberculous joints a minimum age for arthrodesis is suggested but not so for extra articular arthrodesis of the hip This is on account of the great shortening and atrophy of the limb that follows prolonged disuse in the hip

A child with a tuberculous knee or ankle can get about well on a caliper or walking Thomas knee splint but no ambulatory splint other than a big plaster (Fig. 37) will protect a tuberculous hip This is so cumbersome that it is often advisable to do an extra articular arthrodesis at an early age Arthrodesis in young children will bring about an internal immobilization fully strong enough to protect the granuloma from all the strains of wear

and tear and thus lead to its sound healing, but will not always resist the forces of growth under the abnormal circumstances. Bone grafts when fully colonized are alive and therefore plastic to great force continuously and very gradually applied, however resistant to sudden jars. It may, indeed, be necessary, owing to the slow development of secondary deformity, to do a low transtrochanteric osteotomy later on. But the more natural development and growth of the limb associated with the early return of function is of the greatest value, and more than discounts the disadvantage of a possible second operation.

Continued conservative care for fixation.

There comes a time when the patient can with safety be transferred from bed and a frame to plaster with a view to getting up. There then begins a duel between skill and deformity. Well moulded close fitting plasters will do much,¹ but if any one is confident of his powers of holding a hip in a single spica, and would put them to the test, let him choose a lean and placid child with prominent bony points.

Flexion is fairly easily controlled in the long plaster, but adduction is not mastered without a close hold of the opposite tuber ischu, for this side of the pelvis cannot be held up by its anterior superior iliac spine alone if the good hip is left free to flex. For in flexion the tensor fasciae femoris and sartorius bear upon the edge of the plaster just below the anterior superior spine, as the movement proceeds further, the flexing thigh pushes that side of the plaster forwards and upwards, and levers that side of the pelvis down. This tends to adduct the affected hip since it forces the good side of the pelvis downwards in relation to the limb in plaster, bringing the origin of the adductors nearer to their insertion, the process is repeated day after day, the plastic tissue in the hip yielding little by little. The movement is slow and very persistent, it does not show much on hospital records, since, as a rule, it only becomes obvious long after the patient has left hospital. But it is responsible for many cases of late adduction deformity with additional and unnecessary practical shortening. Figs 35 and 36 illustrate this point. It is possible to prevent this adduction within the plaster by a *perineal strap* bearing on the tuberosity either as a firmly applied, well felted strap of plaster or a padded leather groin strap fixed to studs in the plaster (and the former is more positive), but either is difficult to nurse, even in bed and still more so when the patient gets up. This method, though valuable in special cases and used a good deal at Oxford, can hardly become standard.

The safest plan is to include the upper half of the good thigh, the plaster can then be moulded round the tuber ischu and under the anterior superior spine. This hold is safe, for flexion of the good hip, with its leverage action, is prevented (see Fig 37).

At a still later stage in an arthrodesed or ankylosing hip, less 'complete' control is allowable since the adductors and flexors have been well stretched,

¹ See the excellent monograph by Calvé and Galland *Les Appareils Plâtrés*, Paris.



FIG 35 Girl aged 7 Tuberculous hip treated in single long spica plaster
(Radiograph May 1921)



FIG 36 Same case, October 1924—Note adduction deformity!

and the organizing fibrous or bony tissues are becoming sound and better able to resist a strain

By intelligent anticipation we distinguish those cases in which the healing will long remain unsound. The younger the patient, the less closely adapted the raw surfaces, and the greater the extent of unhealthy bone, the slower will be the achievement of any form of ankylosis. In some cases it may take four or five years. In such, the original frame position should be one of fairly wide abduction, and the first plasters should hold this position. Then through the long convalescence, the less perfect hold of the single long spica is sufficient. In these young children, even after the fixation is firm enough to answer Thomas's tests of soundness, there is likely to be a little, very slow insidious movement of flexion and adduction which will bring the limb into the position of choice. But too much abduction is a mistake, for the gain in practical length is more than countered by the strain on the back and the risk of progressive secondary scoliosis.

Third stage.

This is the stage of constructive organization of bone and fibrous tissue, of increasing movement or firmer fixation.

I Mobile group. Provided that repeated tests show that the range of movement is increasing rather than diminishing, the patient may be passed safely through the following programme

- (a) *Extensions and splints* are removed, and the range of movement measured and recorded. Complete freedom in bed is allowed, and the movements of the affected joint are tested every few days. Thomas taught that a joint was improving so long as its range of movement was increasing and that it was cured when no reduction of its range of movement could be discovered on repeated examination after it had been set completely free.
- (b) *Patten and crutches*. If the range of movement is found to be progressively increasing after a fortnight's freedom the patient is allowed up on crutches with a 4 inch patten on the good leg. The range of movement is noted each week, then, if all is well, each fortnight for three to six months.
- (c) *Crutches*. After these, if radiographic and clinical verdicts are favourable, the patient may wear a boot without a patten for an hour or two



FIG 37 Extensive plaster giving complete immobilization of the hip

in the morning If the tests continue to be satisfactory the patient is allowed to leave the patten off more and more, then altogether

(d) *Sticks* Later sticks replace the crutches

(e) *Supervision* Finally supervision both general and local, monthly, for a year or two then less often



FIG 38 Transarticular re-fracture a late phenomenon

A word of caution must be added Some children are so active that they cannot be allowed so much freedom For a time a single Thomas splint may be added to the patten and crutches to be worn during the day and left off at night

II Ankylosis group It has already been stated (p 64) that once fixation is inevitable or desirable operative arthrodesis is the rule in the author's practice But this is by no means universal and the following is an alternative programme

(a) Frame and plaster in bed

(b) Plaster, patten and crutches

(c) Plaster and crutches

At each change of plaster the position of the joint is recorded radiographically, and by noting the flexion deformity, if any, and the relation of actual to practical measurements. As soon as the patten is removed the patient begins to bear weight on the limb, at first only a little, using crutches, then more and more, provided that no discomfort or hint of harm is evident.

At some time in the convalescent period it becomes clear that the union (fibrous or bony) between femur and pelvis is sound, the tendency to deformity is over, but the bone still needs protection from sudden strain or injury. At this point the plaster can be replaced by a single Thomas splint adapted to take lateral bearings on trunk, pelvis, and internal femoral condyle, or the short spica continued till ankylosis is considered sound—then freedom is allowed under frequent observation.

The convalescent stage ends when the healing is sound and strong, as shown by stability of position after splints have been omitted (Thomas's secondary diagnosis of restoration)¹. Additional proof is given by the appearance in the radiographs of stratification of the bone in accordance with the demands of the altered anatomy. The osteoblasts, now long relieved from the depression and distraction of the toxins of the tubercle bacilli, have been able to respond to the stimulating strain of returning function and to rearrange the trabeculation in accordance with new lines of force (Fig. 38).

SUMMARY OF SPLINTAGE

(1) Active stage	Complete immobilization with fixed traction (e.g. Jones Abduction Frame)
(2) Second stage	
(a) For mobility	Traction without complete immobilization (e.g. the Marsh Extension)
(b) For fixation	Immobilization without traction (plaster of Paris) Extra articular arthrodesis
(3) Convalescent stage	
(a) For mobility	Joint free, no weight bearing at first (patten and crutches with single Thomas exceptionally)
(b) For fixation	First immobilization and weight bearing (plaster of Paris). Less protection and weight bearing (reduced plaster or modified single Thomas)

Methods of splintage proved by long service have been chosen to illustrate the plan. Other splints may be used instead.² Those described are durable and inexpensive, they can be made quickly without costly machinery, they do not require repeated fittings, and are not soon outgrown. Being of standard pattern, their manufacture, fit, and use are thoroughly understood by all concerned.

¹ See p. 21.

² For Carshalton method see Traction by Suspension in the Treatment of Tuberculosis of the Hip joint, *Annual Report of the Metropolitan Asylums Board*, 1926/7 p. 361.

OPERATIONS

I. Diagnostic

Indications.

In children diagnostic operations have in the past seldom been carried out, for, as a rule provisional diagnosis (plus treatment) answers all requirements until clinical progress and a series of radiographs have made the diagnosis clear. However, the safety of the diagnostic removal of a gland may bring the advantages of positive information at an earlier stage within reach without the disadvantages and risks of arthroscopy.

In adults, on the other hand, whenever there is uncertainty a diagnostic operation should be considered.

(a) **The removal of a regional gland.** This is a recent introduction and apparently gives as reliable information as arthroscopy. If this is proved after a longer trial it is, as a minor operation free from the risks incurred by arthroscopy (see p. 12), very much to be preferred and is the diagnostic operation of choice.

(b) **Arthroscopy (for adults)** The inspection of the joint and removal of synovia or debris for bacteriological examination. This operation is postponed until the patient is fit for arthrodesis. The exposure of the hip will, if the naked eye appearances are characteristic of tuberculosis, be the first step of an intra articular arthrodesis.

The operation is done with the patient undisturbed on his frame

N.B. The pathologist wants all the tissue we can safely give him especially in doubtful cases with indeterminate naked eye appearances i.e. just the cases in which we need his help most. Give him if you can find it, fluid for smears, cultures, and guinea pigs, and synovial membrane for histological and bacteriological examination. He may have to examine sections from several different parts before finding tubercle bacilli or characteristic histological appearances (see p. 12).

The following is a good example of the value of diagnostic arthrotomy in a doubtful case even in a child.

Case B.U. (Fig. 39)

13 xu 33 *A girl of 13 was sent to the author with a diagnosis of tuberculosis of the hip.* She had been confined to bed for some months. The history was fairly typical. She looked well, her left hip exhibited 75 per cent. limitation of movement in all directions apparently due to muscular spasm. X-ray had been reported normal but some alteration in the epiphyseal region was visible (Fig. 39).

27 xu 33 *Still signs of arthritis in left hip*

9 ii 34 *Diagnostic arthrotomy.* Anterior Smith-Petersen incision, thorough exposure of the front of the capsule. This appeared thickened and rather red, it was opened (very tough to cut through). Immediately a discoloured prominence presented itself in front of the neck, this was a bulging exostosis from which protruded one fairly blunt projection and three very sharp needle-like points. These bony spicules must have pricked the synovial membrane on the slightest movement. The whole bony prominence was removed and the wound closed.

The arthrotomy completely disposed of the diagnosis of tuberculosis. The patient was soon able to get about again.

It ultimately became clear that there had been a disturbance of the epiphyseal cartilage such as is associated with coxa vara adolescents.

The end result has been completely satisfactory.

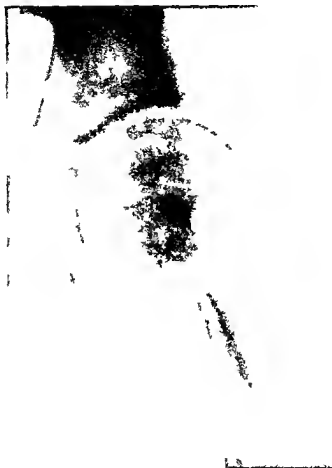


FIG. 39. Case B. I.

II. Operations for Arthrodesis with or without Eradication of Diseased Tissues and Debris

Extra-articular arthrodesis Intra-articular arthrodesis

In this book the word *excision* implies excision and intra-articular arthrodesis. The term *wide excision* is used whenever pseudarthrosis is the aim. In the opinion of the author *excision* should be carried out whenever the focus is so extensive or so active that it is likely to interfere with the stability or with the success of extra-articular arthrodesis alone. For example, in an adult over 30 the disease commonly persists in spite of immobilization whether by splintage or by extra-articular arthrodesis. And persistent active disease is likely to lead to the failure of the ordinary methods of the femoral

extra articular arthrodesis, through absorption of the middle of the graft where it is close to the disease, and where the strain imposed upon it is greatest, for these two points usually coincide

These remarks particularly refer to *high arthrodesis* i.e. ilio femoral arthrodesis. When this takes the form of a flying buttress the extra articular



FIG 40a

FIG 40a b c Radiographs of a case in which Mr Brittain performed an ilio femoral graft arthrodesis

synostosis cannot be relied upon to carry all the strains of function. Ordinarily an ilio femoral arthrodesis relies for lateral strains (abduction and adduction) upon a reasonably fixed point in the region of the acetabulum, and the stability in the end resembles that of three point suspension with the other two points represented by a broad flat synosteal bridge between ilium and great trochanter, resisting antero posterior movement.

High extra articular arthrodesis, then, may call for previous excision of the joint to provide additional stability. On the other hand the later methods of low extra articular arthrodesis would appear to be less dependent on intra



FIG 40c



FIG 40b

articular stability, and in its strongest form the union should be strong enough to take all the stress of function, without any strain reaching the joint. Unfortunately, at the time of writing, the practical experience of this form of arthrodesis is too brief to justify any assessment of its success. There are at present considerable difficulties in the operative technique of the Brittain operation, which, to be successful, must ensure a massive union between ischium and femur (see Figs 40a, b, and c), and there is the splintage difficulty entailed by the angular displacement of the femur during the operation. Trumble's method does not raise this difficulty, but, on the other hand, while Trumble's graft is capable of stabilizing an unsound ankylosis, it cannot carry the whole strain of the limb.



FIG 41

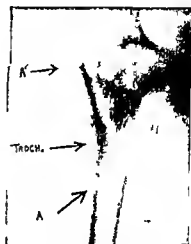


FIG 42

FIGS 41 AND 42 High arthrodesis. Great trochanter approximates to ilium favouring a bridging extra articular graft. (Ex Robert Jones Birthday volume)

High arthrodesis.

Conditions favourable to high arthrodesis are

- 1 A reasonably fixed point between what is left of the head of the femur and what is left of the acetabulum.
- 2 Healthy bone in the ilium above the acetabulum and in and around the great trochanter

Unfavourable.

- 1 The presence of a cold abscess in the area to be occupied by the graft. A sinus in this region is a contra indication
- 2 Extensive femoral or iliac disease

Methods. (a) *Children.* The author has found that the most reliable method in children is that associated with Wilson¹ a very large flap of bone is turned down from the wing of the ilium and inserted into a deep cleft between the trochanter and the neck, or in the trochanter

¹ J C Wilson *Journal of Bone and Joint Surgery* 1933 15, 22

Technique A Smith Petersen incision is carried far back. Almost the whole wing of the ilium is exposed just extraperiosteally, but care is taken not to open the joint. The front of the base of the great trochanter is exposed and a saw or chisel cut, made downwards and outwards from the digital fossa, is levered open so that the great trochanter leans away from the neck leaving a cleft in the bone between their bases (Fig 43). Then, taking a very fine chisel about $\frac{3}{4}$ inch wide, the iliac flap is outlined starting at the anterior inferior iliac spine, passing vertically upwards, then backwards $\frac{1}{4}$ inch from the crest to a point as far back as can be reached. This chisel cut is then brought downwards and slightly forwards to a level about $\frac{1}{2}$ inch above the acetabulum. Sometimes one, sometimes both tables are taken, depending upon the stoutness of the iliac wing. It is often helpful to use a number of curved chisels and to leave several in place while the others are being driven in to indicate the general outline of the flap and by combined tentative leverage, from time to time, to ascertain when the bone flap is ready to be lifted and turned down (Fig 43).

When the flap is free and only held by its base, it is clasped by two pairs of bone holding forceps and lifted outwards then gradually coaxed down deeply into the cleft at the base of the great trochanter (Fig 43). It is generally advisable to reinforce the upper spring of the bridge and sometimes also the lower by packing some additional boggish flakes of bone from the ilium into the hinge of the flap above and sometimes also round its insertion below. The Smith Petersen incision is then closed in the ordinary way.

N.B. This operation, as all other constructive hip operations, is done through a window in a plaster spica or with the patient undisturbed on a Robert Jones frame. In the latter case a spica bandage is put on round the frame, with plenty of wool over the dressing.

(b) *Adults* In adults this flap from the iliac wing does not work well because the rigid adult bone breaks off completely. Good results are obtainable much more easily by using a sliding iliac graft, about $1\frac{1}{2}$ inches wide, taken from just behind the anterior superior spine. This is quicker and requires far less exposure.

The rho-diaphyseal graft (Berck). This method of grafting, initiated by Richard at Berck Plage, is applicable to cases unsuitable for the technique just described on account of disease in the great trochanter. The exposure is the same except that the separation of the glutei is carried much farther down, so that the diaphysis of the femur below the diseased area is exposed. A thick osteoperiosteal graft is then raised from the tibia in one piece and of sufficient length for one end to be imbedded in the ilium above the acetabulum and the other in the femur well below the great trochanter. These thick osteoperiosteal grafts come off the tibia in a curve with the periosteum on the concave side, this curve is left undisturbed and the graft is inserted with the periosteal surface deep and is found to fit admirably into place.

Initially, such a graft is very weak indeed. This method depends for its success on accurate and long continued protection.

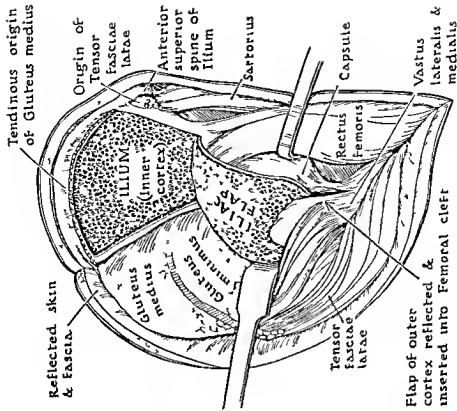
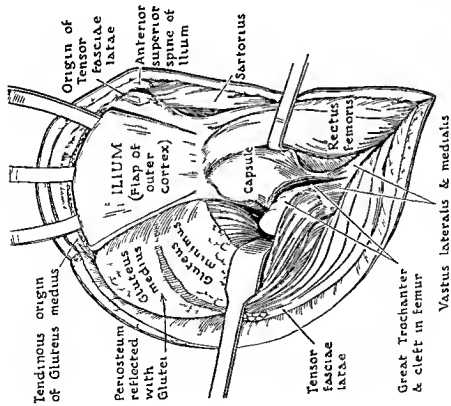


FIG. 43 This illustrates two successive stages in the skin flap extra articular arthrodesis

Low arthrodesis. Ischio-femoral synostosis.

In the opinion of the author a number of cases which would formerly have necessitated amputation or wide excision will in future be treated successfully by low arthrodesis

(a) **Trumble's operation**¹ (see Table 2) This consists in using a specially shaped tibial graft to bridge from the ischium to the shaft of the femur. The approach is, of course, posterior (Fig 44). He uses the standard approach to the sciatic nerve under the gluteus maximus by reflecting the muscle from its insertion. Fig 46 illustrates the X ray appearance one month after the operation and five years later

TABLE 2.

Case no	Sex and age	Date of operation	Present state November 1937		
			General health	Hip joint	Graft
9	M 24	4 vi 36	Well except for some pain in Lt elbow ? Tb Afebrile	Firmly fixed Painless	Very long graft Firmly united No hypertrophy but no absorption
10	F 19	12 viii 36	Well (July 1937)	Firmly fixed Painless	Firmly united Hypertrophied (X ray, April 1937)
11	F 32	(1) 18 xii 36 (2) 12 i 37 Graft elevated from nerve	Excellent Some numbness in foot No pain	Still some pain in hip on walking much less than before Sinus still discharging Hip fixed firmly P M Firmly fixed by graft	Very short graft Strongly united, and hypertrophied
12	F 17	25 v 37	Died 23 viii 37 Acute renal infection complicating stone		Firmly united at both ends No sign of absorption of body of graft

Mr Trumble was kind enough to reply to a letter asking for further information as to the results of his operation and to send me the above Table

I have had four additional cases since. The main features are shown in the enclosed table. One patient died about three months after operation with an acute infection of the kidneys. The hip region was removed at post mortem examination. Everything was in order, the graft being firmly fused with the femur and ischium. Immediately after operation in Case 11 paralysis of the sciatic nerve appeared with pain in the foot. I had to reopen the wound and elevate the graft, which was pressing on the nerve. In this case gross destruction and deformity at the hip joint had resulted in close approximation of the femoral shaft to the ischium and in inserting the graft I had not left sufficient space for the nerve. After the second operation the trouble cleared up except for a little numbness in the foot, and the graft has fused well.

(b) **Brittain's operation**.² This differs altogether from Trumble's in that a typical bifurcation subtrochanteric osteotomy is done and the upper end of the lower fragment is inserted into a pit dug in the ischium below the

¹ Trumble reported this operation in two papers *The Australian and New Zealand Journal of Surgery*, March 1932, and *The British Journal of Surgery*, 1937, p. 728

² Personal Communication

acetabulum Recently Brittain has used a strong tibial graft to reinforce the ischio-femoral attachment He describes his operation as follows —

'The patient is placed on his side, the hip to be operated on being uppermost

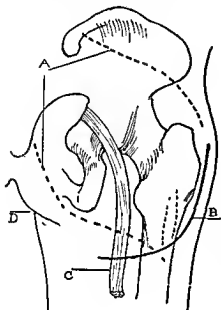


FIG 44 Showing line of incision and how it skirts the insertion of the gluteus maximus into the fascia lata above and the femur below, and crosses the middle line of the thigh below the level of the gluteal sulcus The limits of the gluteus maximus are represented by the broken line, the osseous insertion by the area enclosed in the interrupted line on the femoral shaft A Outlines of gluteus maximus, B Line of incision, C Sciatic nerve, D Gluteal sulcus

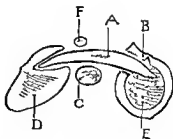
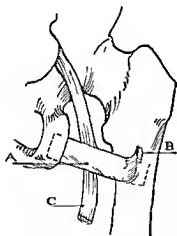


FIG 45 Diagrammatic representation of horizontal section through the graft in position, showing how it arches over the great sciatic nerve and the manner in which the ends are cut to a wedge shape to facilitate introduction Both ends are firmly gripped and cannot get out of position The trap door in the femur is shown replaced The sciatic nerves are shown separated by the graft A Graft B Trap door closed, C Great sciatic nerve, D Ischial tuberosity, E Femur, F Lesser sciatic nerve

The patient is supported either by sandbags or by a special hip rest A bone graft 4 to 6 inches in length is taken from the tibia This should include the crest of the tibia, and it will be necessary to raise the muscles from the

medial aspect of the bone. A 4 inch incision is made over the lateral aspect of the great trochanter starting at the tip and proceeding downwards. The incision is carried down to bone and elevators inserted. A subtrochanteric osteotomy is now carried out at a site previously decided upon. A special chisel with a square ended handle is then inserted through the divided bone and thus is kept in the coronal plane until it abuts against the ischium. It is then gently hammered inwards for a distance of half an inch. An X ray photograph is taken and if necessary the chisel can then be hammered in still



FIG 46 Radiographs of hip joint taken respectively 1 and 60 months after operation. Note the changes in the graft and osseous ankylosis at the hip joint.

farther. It is then rotated through 180° by means of a spanner fitted to the square end, then partly withdrawn and the graft is inserted in its place using the chisel as a guide. The lower fragment of the femur is then adducted and brought into as much apposition with the ischium as possible. Any protruding portion of the graft is removed. A plaster of Paris spica is applied and maintained for four months. It is then renewed as a short spica until X rays show that bony union is complete.

Two stage operation

In adults with active tuberculosis of the hip, the operation of eversion and intra articular arthrodesis alone is inadequate because bony ankylosis is delayed and remains unsound for a very long time. Nor is extra articular arthrodesis alone always enough because in the older and less resistant patients the disease must be excised as radically in the hip as it is in the knee. Any of these operations may prove more severe than has been anticipated and the patients who need them are often ill fitted to stand shock. Every

possible means should be taken to *minimize shock* before, during, and after operation, e.g. the application of a new plaster at the end of the operation should be avoided if possible. It is unsafe to proceed to a grafting operation after a thorough excision. The anaesthetist may say that the patient is still in excellent condition without diminution of blood pressure, but these patients are liable to lose blood pressure dangerously quickly towards the end of a longish operation. It is a wise rule to do the intra- and extra-articular arthrodesis in two stages.

III. For Exceptionally Extensive Disease

- In some cases disease of either the acetabulum or the femur, or both is
- 1 so extensive that arthrodesis appears impracticable, or
 - 2 so active and widespread that life is threatened (most often in patients under 5 or over 50)

It is particularly in tuberculosis of the hip that the area of bone destroyed and replaced by a granuloma, organized but still permeated by living bacilli is sometimes so great that arthrodesis appears impracticable (see Fig. 34). In such cases the author has found it difficult to decide whether to carry on with conservative treatment of the hip in order that sufficient reconstitution of bone could take place to enable some form of arthrodesis to be carried out later on, or whether it would be best to do an immediate wide excision of the affected part. A good many years ago the former course was taken but experience made it clear that the very long continued immobilization necessary was not well borne in adults, and in children led to great atrophy and shortening of the limb. More recently a wide excision of the diseased part has been adopted *involving complete excision either (a) of the acetabulum or (b) of the head, neck, and greater part of the trochanteric region of the femur*.

Case W W

8 x 24 Boy aged 7 years first seen at Out-patient Clinic

This case is of interest in regard to several points.

To begin with the child limped rather intermittently and was brought to my Out-patient Department several times. I found no limitation of movement and failed to come to a diagnosis. The case was seen repeatedly and sometimes *the child limped* and sometimes not but a diagnosis was not made until a fluctuating iliac abscess was detected in April 1925. Even then there was no limitation of movement of the hip but a radiograph taken in June showed a small localized area of rarefaction deep in the ilium just above the joint (see Fig. 47).

After nearly two years in hospital the child recovered with full movements. Points worth notice are: the delay in X-ray evidence, the absence of limitation of movement indicating the absence of infection of the joint and the fact that despite its proximity to the joint the focus remained *extra-articular and the joint was uninfected*.

The object has been threefold

- (a) complete eradication of the extensive focus,
- (b) avoidance of the atrophy of disuse,
- (c) relatively early resumption of function,

(a) Acetabulectomy

Bankart¹ suggested total acetabulectomy in the treatment of tuberculosis of the hip. At the time he advocated the procedure rather sweepingly. His method was very radical and entailed removal of a complete section of the pelvic ring and the head of the femur was allowed to enter the pelvis. End results have not yet been reported.



FIG. 47. Case W. W.

The author has preferred to remove the diseased part of the acetabulum with such iliac bone as has been infiltrated but he has always been able to retain posterior connexion between ilium and ischium behind the acetabulum. The pelvic ring has not been broken and the upper end of the femur does not enter the pelvis.

(b) Wide excision of the upper end of the femur Pseudarthrosis

When the head, neck, and trochanteric region are very widely diseased so that the normal bone tissue over this whole area is replaced by necrosed and sequestered bone and semi caseous granuloma there is no reasonable hope of establishing arthrodesis by any means. There can be no question but that the best interests of the patient will be served by the removal of the whole

¹ Bankart *British Jnl of Surgery* 20 April 1933 p. 301. Presidential Address to British Orth. Assoc. London July 27th 1933.

extent of rotten bone, i.e. by a wide excision in which the aim is to bring about a freely movable flail type of joint. The steps of the operation include

- 1 A complete exposure of the anterior and upper aspect of the joint
- 2 Division and excision of the capsule and synovial membrane
- 3 Division of all structures inserted into the great trochanter
- 4 Dislocation of the remains of the head and removal of all further muscular insertions into the digital fossa



FIG 48 a



FIG 48 b

FIG 48 a Case FL X ray 12 ix 23 Grumbling disease associated with pain and severe flexion and external rotation deformity. Dotted lines indicate the lines of proposed bone section and fascial cap (Ex Robert Jones Birthday volume)

FIG 48 b Case FL X ray 10 x 23 After pseudarthrosis. There is periosteal bone springing from below the fascial cap on the inner side and running up to the inner corner of upper bone section also a little ossification seen lying above the translucent area occupied by the fascial cap. See arrow. A complete fascial cap covering the end of the bone is clearly indicated (Ex Robert Jones Birthday volume)

- 5 A transverse osteotomy usually just above the small trochanter, the site depending upon the extent of the disease
- 6 Excision and erosion of all diseased material in and round the acetabulum

At the end of the operation, traction is applied and maintained uninterrupted throughout the next few months of treatment, this is carried out in the author's practice either on an abduction hip frame (see p 251) or on a Thomas knee splint, the former is preferable for the first six weeks as it gives the soft parts complete rest, but after six or eight weeks the limb can be transferred to a Thomas splint which allows greater freedom. In the author's experience end results are relatively good (Table 3, p 88)

Time will prove whether ischio femoral arthrodesis will replace pseudarthrosis to a considerable extent. Low extra articular arthrodesis does not

interfere with subsequent surgical access to the hip joint. But in the author's opinion some development of the operation is needed to ensure a synostosis sufficiently massive to stand all the strains of weight bearing and activity. In the favourable case with some acetabular stability ischio femoral grafting (Trumble) is, no doubt, excellent but so is the femoral! The test of an operation which can replace the instability of wide pseudarthrosis by a safe ankylosis, arises where the hip is the centre of a tuberculous lesion so extensive and destructive that it cannot offer even a feeble second point of suspension and may, indeed have to be widely excised leaving the ischio femoral synostosis to carry the whole weight of the body plus any incidental angular leverage strains between pelvis and femur. When we remember that standard bones are built to carry weight with a margin of about $\times 6$ or 8 we realize that a mere capacity of weight bearing is not nearly enough for security in the rough and tumble of life.

Low arthrodesis would be the first step in the surgical treatment of such a case, and might indeed be all that was needed. If, however, in the surgeon's judgement the patient would be better for the radical removal of the extensive and, perhaps, active focus this could be done at a second stage.

In the presence, then, of *very extensive disease or persistent active disease, low (ischio femoral) arthrodesis* holds out some promise of advantage.

Grumbling disease.

It is most often in the hip, but only less frequently in the knee, that tuberculosis may remain persistently active or grumbling year after year, five, ten, twenty, or so long as fifty years! In such cases the patient has, as a rule, fully recovered from the lymphatic tuberculosis and the joint focus has failed to heal simply on account of the mechanical strain imposed upon it. If taken in reasonable time the cure of such cases generally quickly follows a correction of the line of weight bearing force by subtrochanteric osteotomy. But here again *extra articular arthrodesis*, high or low, is a more certain and effective method of treatment. Cases F L and M C (p. 60) are striking examples of persistent grumbling activity. In Case F L that of a shoemaker, the author did a wide subtrochanteric resection with the idea of obtaining a pseudarthrosis below the hip and leaving the old unsound ankylosis free from strain. Actually, as is seen in the radiographs, Figs. 48b and 48c, the shaft was reconstituted in the most remarkable way, but



FIG. 48c. Case F L. X ray 1 iv 25. Showing complete consolidation at the site of pseudarthrosis. The fascial cap has proved of no permanent value (Ex Robert Jones Birthday volume).

fortunately, by the time the long lever was reattached to the upper fragment, the ankylosis had become sound, and all was well. This was a striking demonstration of the experience that prolonged grumbling disease with un sound ankylosis is due to the strain imposed by the long femoral lever



FIG. 49a Case D S Represents arthrodesis of left hip

For deformity

Deformity at an early stage can be corrected, either gradually by splintage or by one slow movement under an anaesthetic followed by complete immobilization of the hip on a frame, as in the practice of the author. If left to a later stage operation is necessary.

The existing disability must be weighed and the likelihood of secondary disabilities such as scoliosis and lumbar osteoarthritis foreseen. These matters and the help that operation can give must be considered. At this late stage the problem is purely orthopaedic, and there is no risk of recurrence provided the infected area is avoided and nothing in the nature of an arthroplasty attempted.

When the hip is fixed the choice lies between osteotomy and distant pseud

arthrosis Osteotomy gives stability and is better for those who are on their feet a good deal But pseudarthrosis is worthy of consideration for those who sit at their work and on their way to and from it

Another and a double barrellled indication for *pseudarthrosis* of the hip is the coincidence of caries of the lumbar spine since this when healed means a rigid lumbar spine which runs the function of a fixed hip and furthermore



FIG 49b Shows extensive laceration of L 3 4 5 Case DS more than 3 years later

a fixed hip throws great strain upon the lumbar spine forcing it into the extremes of flexion and extension A pseudarthrosis on the other hand needs no help from and throws no strain on the lumbar spine Figs 49 a b c illustrate just such a case—for in this patient sound arthrodesis of a hip had to be exchanged for pseudarthrosis

When the hip is not fixed the author does a *subtrochanteric osteotomy* allowing the upper fragment to adduct on the pelvis and putting the lower in a few degrees of abduction and flexion

The optimum angle of flexion varies with the occupation and sex of the patient Those who sit at their work and on their way to and from it

welcome at least 30° of flexion and are all the better for 40° or 45° . On the other hand, a man who stands at his work, e.g. stationmaster or general labourer, will be much better with 25° or 30° . Abduction of more than 10° is a disadvantage, and where there is shortening it may be thought advantageous



FIG. 49c Pseudarthrosis as a result of a deliberate operation Case D S

to abduct the hip sufficiently to lessen the shortening by an inch. Internal rotation is a great disadvantage in a fixed hip. Altogether one would say the best position for an ankylosed hip was that of external rotation of 10° to 20° , neither abduction nor adduction (except in some cases of considerable shortening when 10° to 20° of abduction may be best) and flexion of about 30° varying with occupation. Osteotomy, then, will often be advisable in order to correct marked divergence from this position. But one of the strongest indications for osteotomy is that of pathological dislocation with adduction (Figs 50 a, 50 b)

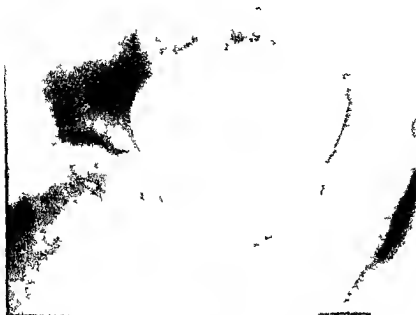


FIG 50a Pathological dislocation with adduction and flexion deformity great functional disability and much practical shortening

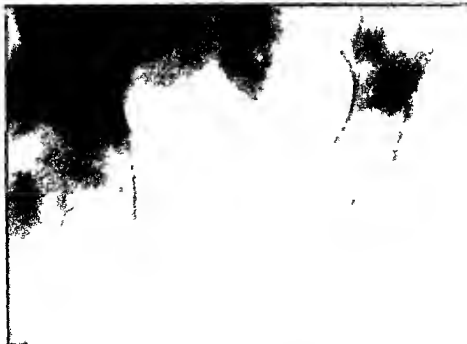


FIG 50b After osteotomy Hip stable abducted

TABLE 3

Pseudarthrosis of Tuberculous Hips

Series of 22 cases

13	Well and working
	Satisfactory
3	Died
3	Untraced
3	Still incomplete

Case D S

- 4 x 28 X ray of Spine complete fusion and good calcification of diseased vertebrae
 , Hip almost complete destruction of head and neck
 Hip very unstable with limited movements
- 7 u 30 Operation Arthrodesis of left hip
- 16 u 31 Discharged
- 26 x 31 Started walking out of plaster Fig 49 a X ray shows bony union
- 18 u 35 Readmitted for reactivity of spinal lesion Fig 49 b X ray shows extensive disease of L 3 4 and 5 Psoas abscess present requiring repeated aspiration
- 22 u 36 Operation Pseudarthrosis Fig 49 c

In Table 4 is an assessment of deformity with the indications for operative correction

TABLE 4

<i>Good</i>	<i>Doubtful</i>	<i>Bad</i>
Mobile Soundly healed Flexion range > 30° AGE > 160 No adduction deformity With strong sound limits Smooth articular movement Little or no deformity Without pathological dislocation	Flexion range < 30° AGE > 140° < 160° Adduction deformity < 10° Limits of doubtful strength Articular movement with deformity of articular surfaces Pathological pseudarthrosis*	Healing still unsound AGE < 140 Adduction deformity > 10° Limits weak Instability Pathological pseudarthrosis unsound or sound but with adduction deformity
Fixed Ankylosis (fibrous or bony) sound and complete Flexion < 50° Adduction < 5° Abduction < 15° Rotation external < 90°	Ankylosis incomplete Flexion > 50° < 60° Adduction < 10° Abduction > 15° < 30° Rotation external > 20° < 40° Rotation internal < 10°	Ankylosis unsound Flexion > 60° Adduction > 10° Abduction > 30° Rotation external > 40° Rotation internal > 10°

> =greater than < =less than AGE Angle of greatest extension

* In ankylosis the degree of flexion deformity desirable depends on age and profession (see pp 82-6)

For severe pyogenic infection

The risks of secondary infection in general and the means by which it can be avoided have been discussed (see p 2a) Sepsis round the hip is often dangerously persistent and may call for very radical drainage as a life saving

need, for sepsis must be stopped, or the patient will inevitably drag out his life to a most weary and wretched end. Only a few months ago the author saw a lad of 20 very ill with lardaceous disease and doomed to die of it. He had suffered from tuberculous hip disease since he was 3. Early on, the joint had become secondarily infected, and he had been in his previous hospital without adequate drainage for nine years. Cases such as this demonstrate the need for radical measures.

The depth of the joint and its anatomical relations make the ordinary methods of drainage ineffective. At the same time a reliable method of drainage can take advantage of the fact that persistent severe sepsis of a tuberculous joint inevitably leads to destruction and involves or requires fixation of the joint, therefore the integrity of the muscles and their nerve supply is no longer a consideration. And when the drainage necessitates wide excision with pseudarthrosis, the integrity of abductors and adductors is of secondary value and should be disregarded if their sacrifice or partial sacrifice will give a better chance of recovery and clean, sound healing. It is only too common for a seriously infected hip to be drained again and again, to the bitter disappointment and distress of the patient. For this reason the author has developed a more radical and decisive method of which the main feature is the wide excision of muscular masses.

Drainage operation for severe persistent sepsis.

Severe persistent sepsis round the hip has been one of the bugbears of surgery, tracks burrow round the neck of the femur and small trochanter, and having penetrated the acetabulum form large, deep, bottle-necked abscesses within the pelvis, which are not easily drained adequately.

It is essential to recognize that it is no longer a matter of drainage of the hip but of a much larger infected and sclerosed area representing a miniature rabbit warren of sinuses and cavities. Twenty years ago the author found that no established standard drainage operation gave good results in these cases. The sciatic nerve obstructed a really broad posterior approach, and vertical intermuscular approach from the front or the side had more obvious failings.

An approach to this deep-seated joint was needed which, as the joint obviously could not be brought to the surface, would bring the surface to the joint by saucerization of the tissues. The advantage of such a method would be not only in the intimate exposure of the joint to inspection, excision, and subsequent drainage, but in the easy access it presents to the adequate drainage of a still deeper intrapelvic abscess via ilium or acetabular floor.

It is often wise to obtain evidence as to the situation and extent of deep tracks and abscesses by lipiodol injection into the various sinuses and stereoscopic radiography. Such an injection should be carried out on the X-ray table. The lipiodol is injected slowly without much pressure. Sometimes the nozzle of the glass syringe is pressed lightly into the sinus, at other

times a small rubber catheter is inserted as deeply as possible to carry the lipiodol

The author's method is of two types. Method A is applied to hips requiring excision as an essential part of adequate drainage of the joint cavity, and Method B to those in which the joint cavity is already obliterated by ankylosis. The principle is the same and lies in a transverse skin incision on one or both sides of the limb and, after wide freeing and retraction, the exposure of the whole extent of the joint by two widely separated transverse incisions which excise the broad mass of tissues between them. These incisions stop short of the anterior crural (femoral) nerve in front and the sciatic nerve behind.

Method 'A'. Indications. The failure of drainage 'down to' the joint and the persistence of septic absorption and fever. In such conditions the joint cavity requires radical drainage and, therefore, the femoral head must be excised and the acetabular floor and surroundings exposed and explored.

Technique. A transverse skin incision is made from the anterior superior spine backwards with the centre an inch or so above the great trochanter. The skin with the superficial fascia is widely freed and retracted. Two deep transverse incisions are now rapidly made (using for the moment gauze compression to control haemorrhage). The upper incision divides the glutei down to the ilium above the acetabulum, the lower first exposes the outer side of the base of the great trochanter opposite the middle of the neck of the femur. The base of the great trochanter is then divided by a wide chisel cut directed obliquely upwards to the digital fossa and the soft tissues cut through on the same line. The whole mass of tissues consisting of glutei and great trochanter is now removed and haemostasis carried out by clamping and then tying the vessels by haemostatic sutures (No 0 or 1 catgut in small fully curved round bodied needles). The outer upper side of the femoral neck, head, and the upper rim of the acetabulum are widely exposed. The head is then excised by a $1\frac{1}{2}$ inch chisel and the acetabular rim by a $1\frac{1}{2}$ inch or 2 inch gouge of suitable curvature (see Fig 51). All the cartilage is cut or scraped out of the acetabulum and carious bone curetted. When ever necessitated by the presence of an intrapelvic abscess the acetabular floor is removed with as much of the neighbouring ilium as will ensure perfectly free drainage.

It is the rule in this operation to leave no cartilage, no diseased bone, no dead tissue, and no dead spaces.

The operation can be done very quickly if the tools are large, sharp and of fine material and thin section. The excision of the broad wedge of abductors provides really good drainage. After the excision of the deep tissues, the author draws the upper flap of skin fairly far down into the wound by a continuous catgut suture, and often the lower flap too. The sutured skin flap covers the freshly cut ends of the sensory nerves. The author has found this point in technique very valuable in this and other drainage operations, as it reduces the pain of dressings and the granulating area. The skin flaps

should, however, not be sutured any deeper than the deep fascia when there has been extensive burrowing infection of the intermuscular planes

The operation is carried out with the patient undisturbed on a Robert Jones double hip frame

Method 'B'. *Indications* In cases where ankylosis has taken place and the joint cavity is obliterated

DIAGRAM of LATERAL
DRAINAGE for Septic
Arthritis of Hip
with Excision
of Femoral
Head

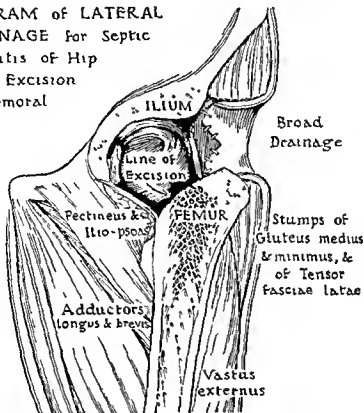


FIG 51 METHOD A

Technique The author makes two transverse incisions cutting out large wedges of the adductor muscles on the inner side and of the abductor muscles on the outer side, this leaves two wide gaps in the soft parts opening directly into the hip joint, one on each side. It is undesirable to remove the head, but this may leave undrained sinus tracks on the inner side below the neck and round the small trochanter, with, perhaps, burrowing sinuses amongst the adductors. In such cases it may be necessary to carry out a similar additional excision of muscular tissue on the inner side. Portions of the pectineus and adductor longus and brevis are thus excised on the inner side as well as of all three glutei on the outer. In front the skin remains intact over the tensor fasciae femoris, sartorius, and rectus, with the femoral vessels and nerve, and behind skin covers what is left of the gluteus maximus together with the hamstrings, the adductor magnus, and the sciatic nerve. As ankylosis exists, splintage is unnecessary.

DIAGRAM showing relations
of Skin Muscle & Bone
after wide lateral
Drainage Operation
on a septic
ankylosing Hip

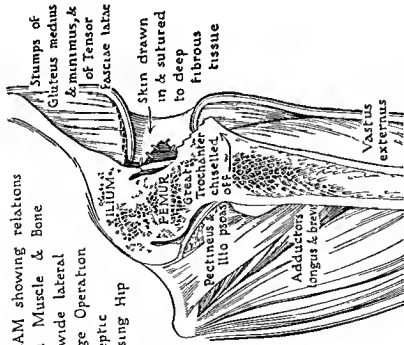
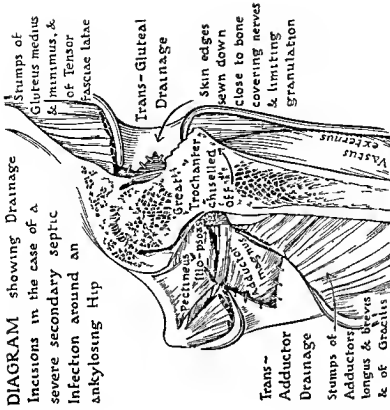


DIAGRAM showing Drainage
Incisions in the case of a
severe secondary septic
Infection around an
ankylosing Hip



110 5 a. This illustrates the method of drainage when an external wound is sufficient

110 5 b. When an adductor drainage is also indicated

Method B

AMPUTATION AS A LIFE SAVING OPERATION

Indications

- 1 In some cases of persistent extensive disease with or without septic infection
- 2 In elderly patients with a bad prognosis

Flaps

The less muscular tissue the better masses of muscle are altogether out of place Only sufficient muscle should be left toward the bases of the flaps to make sure that they will be well supplied with blood Very often the flaps must be designed in relation to sinuses and cicatrices great care should be taken in the design of the flaps they must not be narrow pointed or thin or they will slough

Incision

The author begins the operation by tying the femoral artery and vein through a vertical incision just to the outer side of the femoral vessels and dividing them between ligatures In a much adducted hip it is wise to approach the femoral vessels from the outer side dividing first the upper part of the sartorius transversely 1 or 2 inches below its origin the anterior crural nerve is then divided and the artery and vein finally reached from the outer side for the ordinary route is surprisingly hampered by severe adduction

So far there has only been made a vertical incision to the outer side of the femoral vessels This incision if the sinuses allow is carried downwards and inwards transversely round the back of the thigh then upwards and forwards to bring it back to the middle of the outer side of the original vertical incision This gives a fairly long postero internal flap and a short external flap

Nerves

These are injected with 2 per cent planocaine then crushed and divided two minutes later this short time can be spent in dissection of the femoral vessels in front or in haemostasis when the sciatic has been disclosed Some times the sciatic is intentionally included in a rapid division of the posterior muscle mass to facilitate haemostasis by getting rid of the limb If so it will require shortening it is first gently pulled down by its sheath and injected then two minutes later clamped and ligatured round the crushed portion before division

The avoidance of infection

Everything possible is done to carry out all the main haemostasis flap cutting and muscle division and then so far as possible to protect the raw surfaces before contaminating the wound by opening tuberculous or septic tissues This aim should be in the surgeon's mind even when widespread sepsis and multiple sinuses make its full achievement impossible

When septic cavities in the ilium exist they are scraped out, and left exposed as close to the surface as possible by bringing the skin edges close to the bone.

Excision and erosion of diseased and necrotic tissues.

It is first necessary to get rid of the limb with all that is left of the femur. Whether this means disarticulation of a diseased joint or division of extensively sclerosed and partly calcified granulation tissue, it may require rather rapid and apparently ruthless use of a big cutting tool, and a broad 2 inch gouge will often be the handiest. The moment the limb is away all bleeding vessels are clamped. The wound is then quickly douched with warm (not hot) saline and covered with warm saline towels while diseased, necrotic, and ischaemic tissues are erased and excised. Sometimes drainage of an intra pelvic abscess must be included.

Drainage.

The original flaps will have been designed to facilitate suitable and adequate drainage. This should always be as short and direct as possible. Whenever there has been much sepsis the drainage should be broad, multiple, direct, and favoured by gravity.

Closure.

The wound is rapidly closed by a number of stout, deep, interrupted stitches and accurate approximation of the epidermal edges by fine continuous sutures. This is followed by firm bandaging over a large number of big thick sheets of cotton wool.

Two-stage amputation. Preliminary Pseudarthrosis.

The author has found in the frail and seriously ill patient a very great advantage in carrying out the amputation in two stages. In the first stage, using an incision which will conform to the outer limb of a truncated racquet the hip is exposed and a typical wide excision and a pseudarthrosis is carried out and the wound closed or packed according to circumstances. Two or three weeks later the amputation is completed. Occasionally it may be wise to wait in the hope that the pseudarthrosis alone may suffice and amputation be avoided.

TABLE 5
Hip—Non operative Treatment

Results

<i>Results</i>	<i>1 10</i>	<i>11 20</i>	<i>21 30</i>	<i>31-40</i>	<i>41 50</i>	<i>50+</i>	<i>Totals</i>
Well and working	29	29	9	2	1	2	= 75 = 58 per cent
Untraced	3	9	2	2	1	1	= 18 = 14
Incomplete	11	3	0	0	0	0	= 14 = 11
Unsatisfactory	1	1	2	1	1	0	= 6 = 4
Died	10	2	2	1	0	2	= 17 = 13
	54	44	15	6	3	8	= 130 = 100 per cent

THE HIP

TABLE 6
Hip—Operative Treatment
Results

<i>Results</i>	<i>1-10</i>	<i>11 20</i>	<i>21-30</i>	<i>31 40</i>	<i>41 50</i>	<i>50+</i>	<i>Totals</i>	
Well and working	30	32	13	7	3	2	= 87	= 66 per cent
Untraced	5	7	4	1	0	0	= 17	= 13 ,
Incomplete	8	2	1	0	0	0	= 13*	= 9 ,
Unsatisfactory	2	0	1	2	0	0	= 5	= 4 ,
Died	1	6	1	0	2	1	= 11	= 8 „
	46	47	20	10	5	3	= 133	= 100 per cent

* 2 cases ages not known

CHAPTER VII THE SPINE

POTT'S DISEASE

TUBERCULOSIS of the many parts of the spine forms the largest group of bone and joint cases. The nature of the disease is of course, fundamentally the same and the principles of its treatment are identical, but the complexity of the anatomy, and the presence and delicacy of the spinal cord involve many problems which call for particular consideration.

During the period 1923 to 1937 a total of 319 cases of spinal caries have been treated at the Wingfield Morris Orthopaedic Hospital.

Pathology

(1) *Age incidence* Spinal caries may occur at any age. In Table 7 the percentage of cases occurring in each decade is shown, and it should be noted that the largest figure is that for the age incidence of 20 to 30.

(2) *Site of the lesion* (Table 8) The relative frequency with which the various regions of the spine are attacked is shown.

(3) *Nature of the lesion* The tiny original foci may be anywhere in the vertebral body, but in children are most often close to the upper or lower epiphyseal plate. In typical caries the lesion is seldom confined to one body, and this is a point of great practical importance. Hibbs¹ emphasized this and drew attention to the occurrence of small osseous foci in the bodies of several vertebrae above and below the more obviously involved and extensively destroyed centra. These foci no doubt follow a shower of tubercle bacilli distributed over a number of vertebral arteries at a time when the tissues are sufficiently susceptible to allow the bacilli to develop. *It is impossible at an early stage to discover whether one, two, or a considerable number of vertebrae are involved.*

Caries of the vertebral bodies with destruction of the intervertebral disks is much the most common form of the disease. Occasionally there is a *subperiosteal* infection in front of the bodies *under the anterior common ligament* with little or no erosion. More rarely a tuberculous focus develops between one of the bodies and the *posterior common ligament* and here it generally remains localized, being liable to cause paraplegia without X-ray evidence of bone disease.

A focus appearing in the *lateral articulations*, *laminae*, or *spinous processes* is also very uncommon. Disease confined to the lateral articulations occurs almost exclusively in the upper cervical region.

From the epiphyseal region the disease spreads into the disk and adjacent bone, in adults destruction of the former may be the only lesion seen in the radiographs of an early case.

¹ Hibbs R. A. *Journal of Bone and Joint Surgery*, vol 10 no 4 pp 80, 14 Oct 1933

As the disease advances the eroded and decalcified bone gives way both under the pressure of body weight, aggravated in the dorsal region by the ceaseless grinding respiratory motion. In this way the characteristic deformity of Pott's disease the angular kyphos is formed. Such pressure erosion if unchecked may continue until the spine is supported by the thoracic cage.

Osteogenesis does not occur except at a distance in time or in space from an active tuberculous lesion

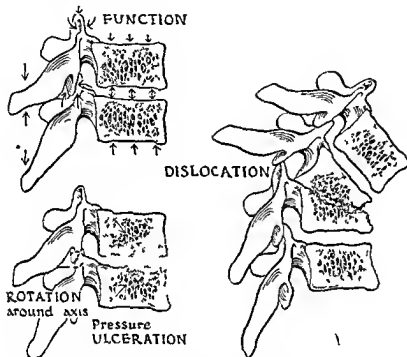


FIG 53 Diagram of dorsal vertebrae in sagittal section to show effect of decalcification

This absence of any constructive bone reaction is peculiarly harmful in tuberculosis of the spine for several reasons. Not only is the spine the foundation of posture, movement, and respiration, and the protector of the spinal cord, but it is so constructed that a defect in the somatic column leads first to a subluxation and in time to a dislocation of the lateral articulations. Advanced spinal caries has been truly and vividly described as a pathological fracture dislocation of the spine. Fig 53 demonstrates the process. This makes it imperative, first that the erosion be checked as quickly as possible and the rotten bone protected from compression, secondly, that special care must be taken to restore the lost stability. Many considerations are involved. It was with the object of minimizing the loss of stability that Menard advocated what he termed orthopedic correction. It must be remembered that in his time there was no operative posterior spinal fusion. Neither Albee nor Hibbs had made their contributions, which have been of

such immense service in this field Menard taught that it was necessary for the stability of the spine that its angulation should correspond to the amount of bone destruction, that healthy bone above the area of erosion should lie in close apposition to healthy bone below. In the lumbar region a certain amount of destruction can be accommodated by telescoping, here orthopaedic correction can often be achieved without angular deformity. Here, too, natural fusion occurs more readily and earlier than elsewhere. Menard's



FIG 53a



FIG 53b

These figures illustrate Waldenström's technique

advice has been accepted by most orthopaedic surgeons, but Waldenström of Sweden has shown that it is possible to avoid an appreciable angular deformity in the presence of considerable destruction by carefully adjusted padding of his plaster beds and later to consolidate the position by means of a strong straight, tibial graft. See Figs 53a and 53b

Cold abscess

This is primarily a collection of debris, and as the destructive process is usually greatest in front, the abscess starts in front and on both sides of the affected bodies. And here, in the *dorsal region* it often remains thus, if destruction is allowed to go on, the abscess may become exceedingly tense and as a result of the internal fluid pressure and the erosion of the whole antero-posterior diameter of the bodies some of the contents may work their way backwards between the diseased bodies into the extra-dural space of

the spinal canal. This, as we shall see, is one of the commonest causes of paraplegia. Much more often, however, the abscess will insidiously travel down one or both sides of the bodies to form the typical distant abscess, e.g. psoas abscess from caries of the lumbar vertebrae.

The appearance of an abscess is ordinarily associated with activity of the destructive process, yet occasionally an abscess will come to the surface long after the arrest of the disease.



Fig. 54 Paravertebral abscess

On the other hand, hints as to the activity of the disease can be obtained from the appearance of the abscess. In the dorsal region, Fig. 54 for instance, one learns to associate a typical spherical or fusiform shape with an active lesion, and a crenated edge with a quiescent lesion. In the course of time the contents of a spinal psoas abscess will often calcify, and the appearance of calcification in a radiograph is reassuring.

✓The contents of an abscess are usually purulent, but they vary in their consistency. In general, an abscess containing thick flocculent material is

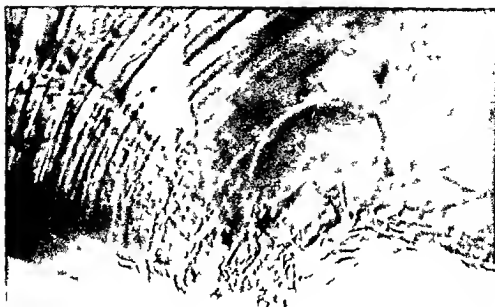


50a



55b

Trus 30c and 55b Poxas abscess



57

Has 500 a 1 and 1000 abscess



58

indicative of a quiescent lesion. A more reliable guide to the state of the lesion is the relative number of tubercle bacilli in a stained film.

The abscess may appear in various sites either adjacent or distant to the bony lesion.

In the upper cervical region a paravertebral abscess is retropharyngeal and presents a large softish swelling at the back of the throat. Lower down, the paravertebral abscess is led by the fascial planes of the neck laterally towards the surface.

In the dorsal region, as has been mentioned above, the abscess may remain localized, and, if so, is a common cause of paraplegia. On the other hand, these abscesses may track along the course of either the anterior or posterior primary division of the spinal nerve, or again they may rupture into the mediastinum or the pleura. In the dorso lumbar and lumbar regions the abscess commonly tracks down the psoas sheath to appear below Poupart's ligament, or more rarely passes out of the pelvis into the buttock and appears on the outer aspect of the thigh. Very seldom it may follow a spinal nerve and appear posteriorly.

But sometimes an abscess which should be cold is warm and tender. This suggests either active inflammation and reaction in its surrounding membrane or secondary pyogenic infection.

A cold abscess may be mistaken for a lipoma, and psoas abscesses sometimes have an unfortunate, if superficial resemblance to a hernia.

DIAGNOSIS

History.

The first symptom is usually pain in the back, felt continuously or repeatedly at the same level generally a tired ache, brought on or aggravated, like tiredness, by prolonged walking, standing or sitting up, or by vibration. The pain has no regular characteristics, it is aggravated by movements of the spine and particularly by jarring. The local pain in the back becomes complicated at a later stage by referred pain due to the pressure on or irritation of a spinal nerve. This often is described as a sense of constriction round the chest, carries in the lower dorsal spine often causes abdominal pain and has led to many a laparotomy from a wrong diagnosis, this not only involves the postponement of the right diagnosis and treatment but may well lead to serious crushing of the diseased area of the spine while the protective muscular spasm is relaxed by the anaesthetic.

Sometimes, particularly in adults the first really noticeable sign is dragging and incoordination of the legs. Not uncommonly, however, the patient's attention is first attracted by a curious soft swelling in the groin or lumbar region not to be mistaken for a lipoma or a hernia!

In regard to general health there may have been a noticeable falling off in stamina and activity. Children may be described as fretful and easily tired and restless at night.

Examination.

The patient may have developed an attitude which is characteristic of the disease in various parts of the spine, e.g. the patient with a lesion in the cervical region is inclined to support his chin on his hands. The muscle spasm, which extends beyond the diseased area, sometimes produces the well known erect posture and 'aldermanic' gait. The patient walks with short deliberate steps to avoid any jarring of the spine. With lumbar disease he may, when sitting, take part of the weight of his body on his hands.

But so far as adults are concerned, every doctor must see hundreds of cases of fibrositis or osteoarthritis before he comes across one case of spinal caries. It is small wonder, then, that this history, when given by an adult, should not always arrest sufficient attention to make the doctor insist upon full examination and radiography.

On examination local rigidity from reflex spasm, especially of the erector spinae, is characteristic. If the case is far advanced there will be a tell tale deformity, a 'knuckle' or an angular kyphosis.

On palpation there may be localized deep tenderness over the spines of the affected vertebrae and on jarring the spine pain will be referred to the same area. But nowadays, with the advantage of radiographic diagnosis, one need seldom have recourse to these signs which involve just a little unnecessary traumatization.

The nervous system must also be examined both on general grounds and because there may be early signs of pressure on the cord or the cauda equina.

Finally, abscesses should be sought, and in lesions of the dorso lumbar spine a fullness can often be felt in the iliac fossa with or without fluctuation.

Radiography.

In children clinical examination may go far toward a diagnosis, often, indeed, the diagnosis is obvious at a glance, but in older patients at an early stage the diagnosis can only be arrived at with the help of X rays, here again, however, though radiographs are much more likely to help than in the big joints, one must be prepared to make a provisional diagnosis in the absence of radiographic signs of erosion. In adults the earliest radiographic sign is often a loss of intervertebral disk space (pinpoint), with perhaps some erosion of the adjacent somatic articular surfaces, and, before long, decalcification of these bodies. In children destructive changes are visible at an early stage. Later varying degrees of destruction and collapse are seen, in antero posterior views lateral angulation and abscess shadows should be looked for.

Differential Diagnosis

For the purposes of discussing differential diagnosis it is useful to consider children and adults separately.



FIG 57 K N age 6 3 years history

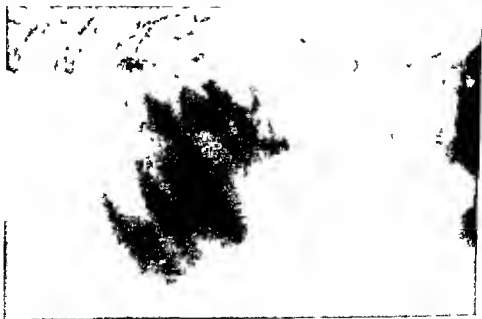


FIG 56 M M age 3 3 months history

Children.

In almost every case but perhaps most in children, the doctor's difficulty arises from the insidious undramatic onset. A mother may rather casually bring her child saying that he or she gets unduly tired in the evening and liable to aches and discomforts, and the doctor may so easily and almost as casually reciprocate with a tone or change of air! With early Pott's disease



FIG 58 Endosteal forms

a child is 'out of sorts' and 'run down'. Other conditions which may be mistaken for Pott's disease are the following

1. **Osteochondritis of the spine.** Age incidence 6-12 years. This is an extremely rare condition (illustrated in Fig 59), often called Calve's disease,¹ belonging to the group of epiphyseal disorders, misnamed osteochondritis, associated with a vascular accident and strictly analogous to Perthes' disease, Köhler's disease, &c. See pp 40 and 190.

The condition is apparently due to a temporary arterial ischaemia of the affected centrum due to embolism or thrombosis of the artery or arteries supplying the affected part. It exhibits the resultant aseptic necrosis characteristic of this form of osteochondritis.

2. **Developmental abnormality.** Age incidence 10-16 years. Fig 60

¹ Calve. *Journal of Bone and Joint Surgery*, 7, 41, 1925.

illustrates another form of 'osteochondritis' in which the plate of the anterior corner of the affected vertebral body is separated off either for a time or permanently. The radiographic picture might be mistaken for that of some infective process. Actually the condition has no pathological significance, nor any symptoms.



FIG. 59 G.S. Calve's disease

3 Scheuermann's disease Age incidence 6-14 years. This is an epiphysitis affecting a number of vertebrae and producing fragmentation and increased density of the epiphyseal plates and some wedging of the vertebral bodies. It gives rise to a rounded kyphosis, not an angular kyphosis, and the relative freedom from pain, with an absence of general symptoms, complete the distinction (Fig. 61).

4 Schmorl's disease Age incidence 12-24 years. Schmorl's disease is a derangement of the relations between the intervertebral disks and the vertebral bodies, associated with a defect in the upper or lower growth plates of the bodies and partial herniation of the disks upwards or downwards. The

resulting disturbance of the anatomical relations appears to interfere with the normal stability of the part, and patients are liable to persistent localized backache very suggestive of spinal caries, but the length of history, the absence of any angular deformity, and the radiographic picture will dis-

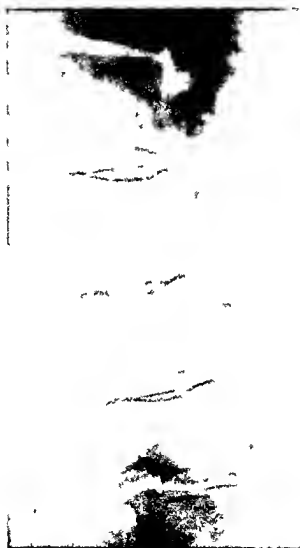


FIG 60 MR two forms of the disturbance of the osteochondral relations The upper represents the so called Schmorl's disease

tinguish this from caries The X ray appearance (see Fig 60) will be recognized once its characteristics have been fully grasped It is, of course, important that neither Scheuermann's nor Schmorl's disease should be mistaken for tuberculosis lest the parents be unduly alarmed and the patient put through a long course of unnecessary immobilization Treatment varies with the severity of the symptoms and the radiographic changes Often nothing

more is required than a certain amount of daily rest in decubitus, erector spinae exercises, and some restriction of activity; but in severe cases six months or more on a plaster bed, giving rest and a gradual correction of the rounded kyphosis, is necessary, and must be followed first by plaster jackets in full extension and later by a light support and postural exercises

5. The kyphosis of 'rickets'. Age incidence 1-10 years. A number of



FIG 61 Adolescent kyphosis. Some degree of osteochondritis

young children show a prominent rounded kyphosis in the dorso-lumbar region without much in the way of the general manifestations of rickets; this deformity is rounded rather than angular, mobile rather than rigid, and quite painless. Lateral X-rays show the deformity without any sign of inflammation, erosion, or disorganization of bodies or disks.

6. Adolescent kyphosis. Age incidence 12-18 years. This is a similar condition arising in children either from poor posture or as a result of a congenital tightness of the hamstrings. Lambrinudi pointed out the association of these conditions.¹ This congenital tightness is shown by the anterior

¹ Lambrinudi, *Brit Med Jour*, 3 Nov 1934, 2, 800

superior spine remaining above the level of the great trochanter when the patient stands and tries his utmost to touch his toes without flexing his knees (Fig 62). This movement should not be forced.

7. Fusion of unknown origin probably developmental. A child or adult may be seen on account of the deformity due to an angular kyphos



FIG 62 Adolescent kyphosis associated with strongly positive 'Lamborghini' sign. The anterior superior spines and level of great trochanter are marked

but without other signs or symptoms. Radiographs may show the fusion partial or complete (Figs. 63 and 64) of two vertebrae. There is no decalcification, and these conditions have no pathological significance except that in later life there may be a liability to discomfort (Fig. 65) from mechanical strain above or below the deformity.

8. Scoliosis. At first sight it would appear impossible to mistake scoliosis for Pott's disease, and this is so in the vast majority of cases. But the author has on one or two occasions found it extremely difficult to distinguish an

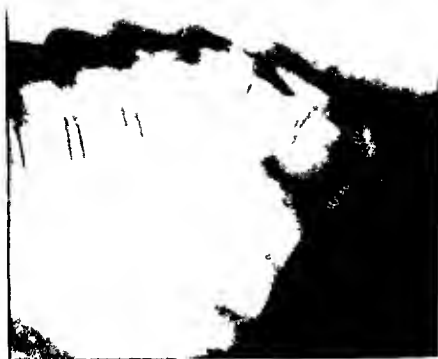


FIG 64 Fusion of vertebrae

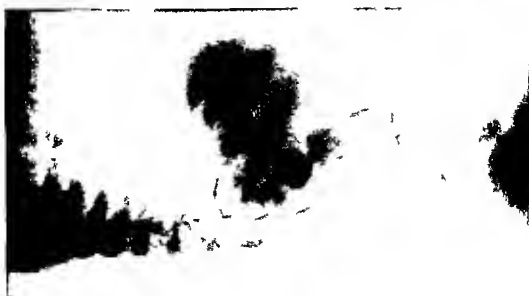


FIG 63 SAC at 14 months Fusion of unknown or gun probably is eloquent

upper dorsal scoliosis beginning in the first year of life from Pott's disease. Radiographs at this age in the upper dorsal region are rather inconclusive, and one must in such an event treat the patient on a spinal frame for a time on a provisional diagnosis. At the other end of the scale are those cases of



FIG. 63 Fusion of vertebrae. Two pairs of bodies involved.

great deformity such as are illustrated in Fig. 66. The scoliosis has almost disappeared in the extreme degree of kypho lordosis. This deformity may be mistaken for Pott's disease, and this is still more likely in regard to those very rare cases of paraplegia resulting from scoliosis. In such cases the paraplegia is not the effect of pressure from disease, but due to the extreme distortion of the spine. Laminectomy alone is, of course, utterly futile, if something radical has to be done it will involve extensive operation, including probably section of intervertebral nerves on the convex side and radical division of



FIG 67 Scoliosis showing no erosion, pincement or decalcification



FIG 66 Primarily a scoliosis

pedicles on the concave side, in order to allow the cord to adopt a straighter, freer course.¹ But the treatment of scoliotic paraplegia is in truth very unsatisfactory. The condition of the cord is analogous to that in some cases of late Pott's paraplegia associated with extreme deformity, and is probably

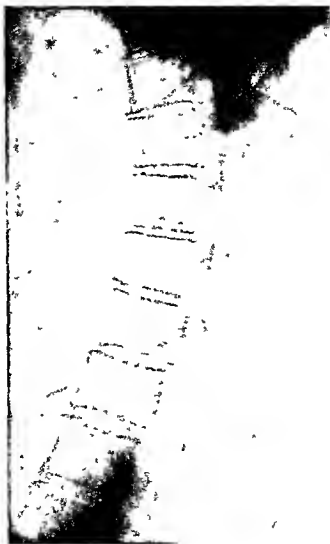


FIG. 68. Spondylitis

due to cord atrophy from prolonged strain and tension, rather than to any cause which can be relieved by operation.

The distinctive feature of scoliosis, as against tuberculosis, is the absence of erosion, pincement, and decalcification (Fig. 67)

9. Rheumatoid spondylitis. In adolescents or adults (Fig. 68). This leads to a rounded kyphosis, involving many vertebrae akin to polyarticular rheumatoid arthritis. Lateral radiographs show more or less equal narrowing

¹ Seddon recently described a lateral approach (B O A Meeting, June 1938, as yet unpublished).



FIG 70



FIG 69

FIGS 69 and 70 Spondylitis Rhizomelica

and wedging of a number of disks, and in the end some wedging of the bodies with general decalcification but without erosion. It occurs in an extreme form in elderly people, female far more often than male, and in these the decalcification may be so extreme that vertebral bodies collapse (pathological crush fracture) with formation of an angular kyphos. Typical root pains follow and one is at once confronted with the more likely diagnoses of tuberculosis or secondary carcinoma. The radiographic evidence of rheumatoid spondylitis throughout the dorsal and lumbar spine, together with a con-



FIG. 71 Appearance of sacro iliac joints in early Spondylitis Rhizomelique

gruous clinical picture, and a history of a stiff uncomfortable spine too long for either tuberculosis or carcinoma, are strong diagnostic points. The absence of any discoverable primary growth and of any history of an operation for such a growth is confirmatory but by no means conclusive, for secondaries to intestinal carcinomata in old people not uncommonly become manifest before their primary growth.

10. Spondylitis Rhizomelique, or ankylosa. Age incidence 18–30 years. This is a curious ankylosing spondylitis which affects the whole spine, except a few of the upper cervical vertebrae, and if it runs its full course welds it into one solid and completely rigid mass of bone which includes the costo vertebral joints (Figs 69 and 70). Although the fully developed disease is easily distinguished from tuberculosis of the spine it may begin with local pain and rigidity, and be difficult to distinguish except by the characteristic development of ankylosis. It is, however, possible to identify this disease at an early stage by radiographs of the sacro iliac joints (Fig 71). This condition, then, is characterized by an

early affection of the sacro iliac joints ending in fusion, and by a painful spondylitis. The hips are commonly involved with perhaps insidious but solid bony ankylosis. The part of the spine affected is painful until it becomes ankylosed, and the process travels slowly from one part of the spine to another.



FIG 72 Extreme osteoarthritis

11. Osteoarthritis Age incidence over 40 years. In the elderly, pain in the spine is commonly caused by osteoarthritis, and this pain may be 'referred' in the form of sciatica. Radiographs, with their evidence of osteo-genetic reaction rather than of erosion, will distinguish this condition from tuberculosis (Fig 72). And it is important that this investigation should be undertaken, lest caries should remain unrecognized in a patient whose pain and stiffness is loosely diagnosed as osteoarthritis.

12. Pyogenic disease of the spine. (Figs 73a and 73b) This is rare



FIG 73b



FIG 73a

FIG 73a and b Pyogenic disease of the spine

It may be primary or part of a pyaemic infection. The infection differs from tuberculosis in that the spinous processes, pedicles, and laminae are involved about as often as the bodies. Perhaps the commonest situations are the lower lumbar vertebrae and the sacro iliac joints, but, so far as the posterior parts of the central column are concerned, there appears to be no favourite site.

There are two clinical forms—the acute and the chronic. In the former the



FIG. 4a. Woman over 60. Secondary carcinoma.

symptoms are very acute and an abscess quickly collects, in the lumbar and the sacro iliac regions the abscess is often very deep and requires a good deal of penetration preferably by Hilton's method in order to drain it. The differential diagnosis of this type from tuberculosis is largely a matter of history—sudden onset, high fever and acute pain. No radiographic abnormality is as a rule detectable within the first few days.

The chronic form except in its distribution is much more like tuberculosis—a slow developing abscess in connexion with the laminae may cause paraplegia—and this differs in its march from the typical Pott's paraplegia in that the sensory columns are likely to be affected first. The diagnosis may be suggested by a high leukocyte count and confirmed by the type of pus and microscopical examination of a smear and the culture afterwards. An

immediate microscopical diagnosis is valuable in order that drainage may be instituted

13 Neoplasms (a) *Secondary carcinoma* Age incidence over 40 years

This is very rare except after middle age but it is sometimes most difficult to distinguish from caries particularly when one body has collapsed. The absence of any obvious primary growth must be discounted though a positive history of a previous mammary or other carcinoma is more than suggestive (Figs 74a and b). In metastatic carcinoma there is relatively less knuckle or angulation and relatively more pain. There is an even and often extreme decalcification and total collapse rather than progressive erosion but occasionally radiographs will show bone flakes in the paravertebral tissues which in appearance and position simulate the bone debris of caries. The metastasis to a prostatic carcinoma may show increased density of bone.

(b) *Sarcoma* (Figs 77a and b) This usually involves one body it is very rare. But an osteolytic sarcoma of the lateral mass of the sacrum is not very uncommon.

(c) *Multiple myeloma* Age incidence 30-60. Radiographs show decalcification advancing to total replacement localized to one vertebral body or more often several. Radiographs of other bones may show similar pictures. The diagnosis is confirmed by the discovery of Bence Jones proteose in the urine.

(d) *Haemangioma* Symptoms indefinite pain occasionally paraplegia. Radiographs show a characteristic mottling of the body and in antero-posterior view the replacement of lateral concavities by convexities the body has lost its waist.

14 Spondylolisthesis (Figs 77a and b and 76) Age incidence 8-18 years

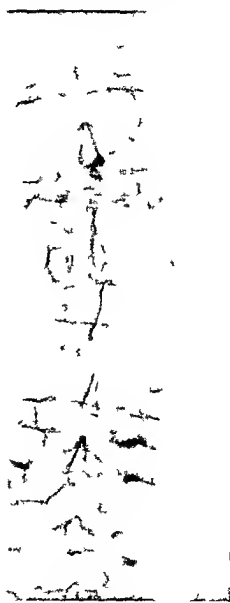


FIG. 4b



Fig. 70a Lateral view before treatment

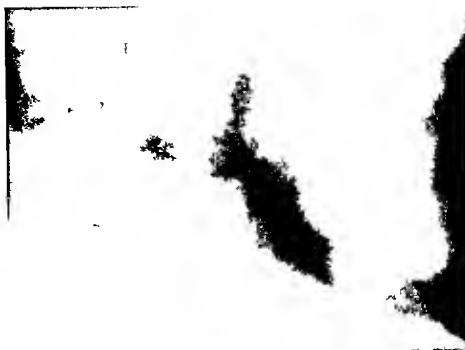


Fig. 70b Same case after treatment. A graft carrying the weight from the 3rd and 4th lumbar vertebrae to the sacrum is in place. No further displacement can take place.

This is a displacement of the fifth lumbar on the sacrum. History either a parent has noticed deformity or the patient complains of stiffness and aching in the back, and pain down the outer sides of the lower limbs.

The condition is due to one of two causes, most commonly to a defect in the development of the vertebral ring between the body and lateral articulations on both sides. This allows the body to slide forward, leaving the lateral

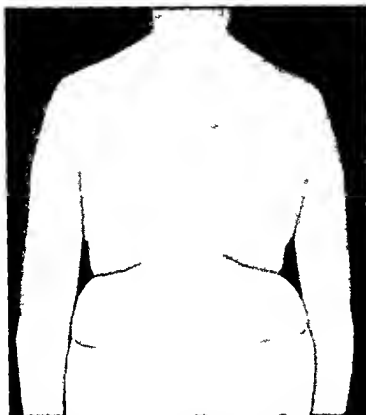


FIG. 76 K P The characteristic appearance of spondylolisthesis

articulations in their normal positions. Occasionally, however, this subluxation is allowed to occur owing to a defect in the lateral articulations themselves.

The back view of the patient is characteristic (Fig. 76) and the radiographic appearance decisive. The deformity seems developed in adult life.

Case D B H First seen 6 x 35 with a history of increasing pain and stiffness of the neck with a very large swelling behind the back of her throat. There was a definite history that there had been leakage from this soft swelling into the throat. There was embarrassment of respiration and difficulty in swallowing.

The radiograph showed extensive destructive disease of C 3, 4, and 5 with what appeared to be an enormous pre-vertebral abscess. The swelling felt soft, but on inspection through the mouth there was no appearance of leakage.

The patient was put on a frame with head piece and the swelling was approached laterally with a view to exploration and a lateral evacuation if it proved to be an



FIG 77 a DBH Saitoma A remarkable case



FIG 77 b Same case

abscess as seemed probable though not fully certain. With diathermy for control of haemorrhage in case of need I exposed the mass inserted a needle with negative result cut out a portion which proved to be solid dark red material suggestive of giant cell tumour. It seemed worth while endeavouring to remove the tumour. I did this by means of blunt dissection and gouge excavation of the vertebral bodies using diathermy haemostasis.

I put her in a plaster collar 26 v 36 and sent her to Dr Webster of the Middlesex Hospital for radiotherapy. She did very well quickly lost her pain and all embarrassment of breathing and swallowing.

On 8 m 37 I strengthened the area of destruction by posterior spinal grafting. (See Fig 77 b)

She was last seen 26 v 39 apparently perfectly well.



FIG 78 Kummell's disease

15 Kummell's disease This condition is characterized by pain in the region of a wedged vertebral body and is a late manifestation of a crush fracture. In some cases the original fracture may have been impacted with little immediate deformity. Such a condition is easily missed at the time and will be so missed unless lateral radiographs are carefully examined. This is serious because lack of protection is likely to lead to a severe secondary increase in deformity.

Occasionally it may be very hard to differentiate Kummell's from Pott's

disease. Valuable pointers in favour of the former are an emphasis on accident in the history and the survival of the intervertebral disks. Radiographs show a wedge shaped vertebra with disks still present though sometimes badly distorted and narrowed.

16 Lumbago An adult complaining of pain in the back coming on insidiously and proving persistent is not suffering from lumbago, and if on

examination there is loss of mobility of the spine the diagnosis of Pott's disease should be excluded by radiographs before the case is labelled as one of fibrositis or strain.

17. Hernia of the intervertebral disk¹ The central part of the nucleus pulposus of the intervertebral disk sometimes herniates backwards producing a rounded prominence in the anterior wall of the spinal canal. This may give rise to an indefinite pain in the back with referred pain down one or other leg or both legs due to pressure irritation of the cauda equina. It is indeed a specific cause of an obstinately intermittent sciatica.

The extrusion of the nucleus pulposus causes a narrowing of the disk space which may be but is not often, sufficiently marked to resemble the pincement of early caries. The absence of X ray changes in the majority of cases and the relation to trauma will help to make the

diagnosis. Rest in bed relieves the pain, but it returns later. The condition can be provisionally diagnosed by lumbar puncture and the cerebrospinal fluid picture and confirmed by lipiodol injection with accurate radiographic investigation on a tilting X ray couch. The filling defect is opposite the disk whereas in the spinal tumour type of posterior caries (subflaval) it is opposite a body.

18 Aneurysm The pain of aneurysm may be mistaken for that of Pott's disease. But it should as a rule be possible to distinguish any anterior pressure absorption due to aneurysm from the anterior erosion due to subperiosteal tuberculosis: the former is shaped, clear cut, and not associated with irregular erosion and decalcification.

¹ Beadle O. A. Medical Research Council Special Report Series No 161 1931 gives a full list of references.



FIG. 79 A woman of about 45 with an angular lyphos due to a collapsed vertebra associated with osteitis deformans.

19. *Paget's disease* (*Osteitis deformans*) Age incidence 40 years upwards Occasionally one or more vertebral bodies may collapse as a result of this disease, producing a clinical picture as regards both angular deformity and pain exactly like that of tuberculosis Here the age period may be suggestive, other bones may be affected, and the radiographs of the spine, particularly lateral, will demonstrate the typical coarse trabeculation of *Paget's disease* (See Fig 79)

TREATMENT

General.

The period of conservative treatment in decubitus is necessarily long if evidence not only of arrest of erosion but of advanced recalcification is awaited before the patient is allowed up Children can with advantage be kept lying down throughout this period, for they thrive while at rest in the open air Most adults, however, cease to gain in health and activity after six months or so, especially if strictly immobilized on any form of splint or plaster bed, and a little later may begin to lose rather than gain Posterior spinal fusion is indicated in adults earlier and much more often than in children The building up of a strong (internal) posterior spinal support is of advantage earlier in order to enable the patient to get up more quickly, and more often because in adults sound reconstitution of the vertebral bodies seldom takes place At the same time it is essential to regard three things first, that the operation should be postponed until the patient is in good general health, second, that for some months after the bacillaemic shower which initiated the disease radiographs may not indicate the total number of vertebrae which were infected by bacillary deposits, third, that the protection of the spinal lesion afforded by the operation does not lessen the need for general treatment

To disregard the second of these points may be particularly unfortunate, early radiographs will have shown the broken down areas in perhaps one or two centra but not infiltrated areas in several others above or below, with the result that the extent of the fusion is insufficient and some outlying lesion may develop just above or below the protected area Sometimes such a lesion will be dormant and only become active and painful a year or more after the patient has left hospital and resumed some activity Nothing is more disheartening to the patient or disappointing to the surgeon

Operative fusion is an incident in general treatment, but it will be realized that its timing is of considerable importance The general treatment begins before the graft and will be carried on after for a period which cannot be laid down in a book, but must be judged in regard to each case In adults, particularly, the chance of successful general treatment comes but once, and unless this none too golden opportunity is grasped and made the most of, the patient is likely to become the victim of other metastatic lesions due to the persistently active disease of the mediastinal or retroperitoneal lymph glands The first few months of general treatment comprises almost complete rest of

the body The patient is given all the advantages of an open air hospital with periods of exposure to the sun and wind, is fed well and kept content and interested, by environment, education, and occupational therapy

Local

I In the active stage.

At this stage the spine must, as a whole, be immobilized on some form of dorsal splintage in full extension or, in some cases, in hyperextension. If there is an angular deformity, gradual correction, by development of compensatory curves is undertaken. This means direct pressure by body weight on the whole of the kyphos. The object of the manoeuvre is, indeed, to push the kyphos forward as a whole while preserving the apposition of the diseased vertebrae and to bring the commencement of the compensatory curves as close as possible above and below. This is achieved by the use of carefully placed, and progressively thickened, 'kyphos pads' so arranged as to assist in the formation of adequate compensatory curves just above and below the site of the lesion (Fig 80). Such 'kyphos pads' are quite as necessary with a plaster bed as with a frame, since the plaster bed can only be carefully moulded to fit the kyphos in the first place, and pads are necessary in order to apply a gradual and progressive correcting force. The pads are first accurately fitted to the kyphos so that they hold and evenly control the whole area of disease (but no more), at the same time protecting bony prominences from undue pressure. Their surface area is not subsequently increased, but an additional layer of felt is placed between the pad and the plaster bed at a turning about once a week.

The Robert Jones spinal frame is designed to present a comfortable smooth surface for the patient's back (see Appendix). The abdomen and chest are practically free and the patient can lie on the frame undisturbed for weeks or months. But regular weekly turning is advised after the first two months, in order to permit complete drainage of the kidneys, but whenever the occasion arises for 'turning' the patient on to his face, a 'turning case' is available. This 'turning case' (Figs 81a and 81b) is made when the patient is first put on the frame and is kept always available for the particular patient. By this means turnings for inspection of the back, for additions to the correcting pad, for preparation for operation, for the operation itself, and for subsequent dressings are carried out without any interruption of the immobilization of the spine.

The method is applicable to a frame or plaster bed which is free to be lifted, but not applicable to complex plaster beds fixed to heavy wooden frames. In the present work the author has had to confine himself so far as the spine is concerned to a description of the Robert Jones spinal frame and the straightforward plaster bed. Indeed, he feels that these are universally applicable and that once their management and turning are clearly understood by the hospital team, no difficulties are likely to arise. Those, however,

who wish to study alternative methods of immobilization are referred to the following descriptions

For special problems of nursing patients with paraplegia on frames or plaster beds see p 241



PAD protecting Kyphos but pressing it forward as a whole and developing Compensatory Curves just above and below

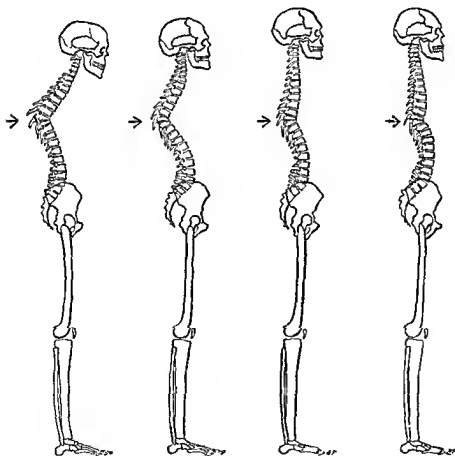


FIG 80 Diagram

II Stage of arrested activity

This stage may be said to have been reached three months after the various signs of a favourable general response have appeared, such as

General 1 The absence of fever

2 The progressive loss of weight has changed to gain

3 An aspect of illness has changed to one of health

Local The local arrest is much more definitely assured when one can

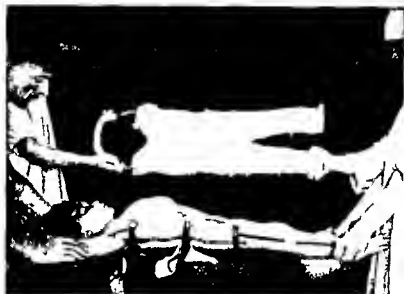


FIG 81a Turning case



FIG 81b

detect radiological evidence of the arrest of erosion by clearer outlines and more normal calcification

Treatment at this stage differs in children and adults

(a) *Children* A modification of the rigidly enforced immobilization in dorsal decubitus is now allowed. The patient can be turned on to an anterior hyperextension plaster bed. The position assures a complete avoidance of flexion of the spine with associated compression strain on the bodies. At the same time there are the advantages of

(1) the change of position after long dorsal decubitus

(2) free flexion of the knees

- (3) the free use of the erector spinae and the posterior muscles of the shoulder and neck, and
- (4) natural drainage from the kidneys



FIG 81c



FIG 81d

Children thrive on such treatment, and should be kept thus splinted until the disease can be considered cured

(6) *Adults* Since adults do not respond well to a very long period of immobilization posterior spinal fusion is indicated when their general condition has responded to treatment

But operation, although allowing the patient to get up earlier than would otherwise be possible *must not be regarded as cutting short the period necessary for successful general treatment*. Spinal fusion is always followed by at least three months' strict immobilization, another month in bed and a further period of ambulatory convalescence. This fades into after care, i.e. a consideration of home and working conditions, climate, and so on.

Fusion is indicated, as a rule, in adults because sound reconstitution of the vertebral bodies does not take place naturally. Moreover, grafting provides



Fig 87 Localizing radiograph showing metal marker

a strong internal splint which is in the author's opinion, the best guarantee against local recurrence of the disease. But it will not prevent the occurrence of disease elsewhere if general treatment has not been continued long enough to ensure healing of the primary tuberculous adenitis.

Spinal bone graft operation. Throughout this operation, as in laminectomy the principle of continued immobilization of the spine is obeyed. The patient is anaesthetized on the frame or plaster bed, the turning case put in position, strapped on, and the patient turned. The frame or plaster bed is then removed, and the portions of the back away from the field of operation are covered with hot, thickly-padded sterile towels.

It is almost always advisable to have a localizing radiograph taken before operation, using a piece of metal opposite a prominent spine which is marked by a scratch on the skin (Fig 82).

It is usually wise to include the spines of one or two vertebrae above and below the diseased area.

The incision is made slightly to the left side to keep the sear away from the prominent spinous processes, and so that the motor saw may be used unhampered by retractors on the *surgeon's side*. The skin flaps are then reflected, the bleeding stopped, and the skin edges towelled. Then a continuous long central incision is made through the supra- and inter spinous ligaments, traversing the summit of each spinous process. This is facilitated by half grasping each process with toothed dissecting forceps as the knife passes over it. The motor saw is then used to flake off either side of each spinous process. This divides the spinous process into three parts, an undisturbed central portion and two lateral portions which remain attached to the muscles. A chisel or osteotome (about the same width as the laminae), is now used to separate these lateral flakes outwards, together with the periosteum of the bases of the spines and laminae. The resulting space is rapidly and firmly packed as it is opened up, and so one passes up the spine on both sides. The length of graft required is now measured with a probe, but the packing is left in place.

Grafts of the Albee type are now cut, or have already been cut by an assistant from the tibia. If there is no marked kyphos, these grafts can be broad and straight, but if there is much angulation to the kyphos, either the grafts must be cut to fit the deformity, or multiple very narrow grafts and flexible grafts are used. The author in such cases almost always uses a pair of broad flexible osteoperiosteal grafts to cover the bundles on either side. The grafts are held in place by strong chromic catgut suturing of the supraspinous ligament which brings the lateral flakes of spines into contact with the grafts. Deep mattress sutures are employed at the top and bottom of the incision to make sure of holding down the ends of the grafts which show a tendency to spring out. If one or more spinous processes are prominent, they are nipped with bone cutting forceps and bent to one side under the suture line.

After the skin has been closed and the dressing applied, the plaster bed or frame is placed in position, strapped on, and the patient turned into the supine position. The turning case is then removed, but its warm wool padding left for the time being undisturbed on the patient.

The whole procedure takes between twenty and forty minutes, and since the use of the motor saw has eliminated hammering, causes little shock.

Variations of the above technique. 1 *The H graft*¹ This procedure was introduced by the author for use in two circumstances

- (a) Where a short stout synostosis between two vertebrae is required, in cases in which there is reliable evidence that the disease is confined to the adjacent surfaces of these two vertebrae
- (b) When on account of extensive destruction, 'fracture dislocation' type, very great strain will be thrown on the synostosis at a particular point, which will be between the lowest spine of the upper segment and the highest of the lower segment. A pseudarthrosis at this point is only

¹ Girdlestone, Presidential Address, *Proceedings of the Royal Society of Medicine* Nov. 1932, vol. 26 (Section of Orthopaedics)

too common and means that the whole object of the operation is lost. The 'H' method is of great value in providing great extra strength at the point of strain.

2 *The one sided graft* If one is grafting for stability, and there is at the same time the possibility of a future laminectomy being required, it will be



FIG. 83 This illustrates dorsum of the graft at the point of maximum strain, an argument for the addition of a cross section of graft (H) between the spinous processes at this point as illustrated in Fig. 84.

helpful to graft strongly on one side only, i.e. the right. For the performance of laminectomy some time after bilateral spinal grafting is very difficult and dangerous.

3 *The lumbo sacral graft (fish tail grafting)* The difference in technique here consists in shaping the grafts in a special way. These broad thin ends are so designed as to be placed on the back of the sacrum, which has been prepared by Hibbs's method of turning up multiple tiny osteoplastic flaps with a fine narrow chisel or gouge and hammer. The upper part of each graft is of the ordinary Albee section. The broad shallow end of the grafts

placed on the rawed surface of the sacrum ensures a really strong fixation of this end which is otherwise liable to be precarious. Furthermore the ordinary Albee graft is ill adapted to fit on the sacrum since it forms an awkward prominence under the skin which it may threaten to perforate.

The preparation of the sacrum to receive the graft is always a delicate task.

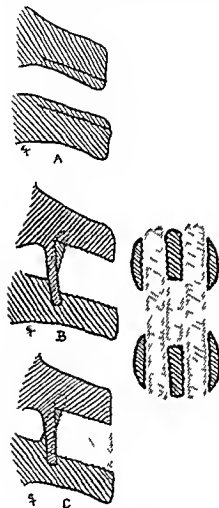


FIG 84 The H graft

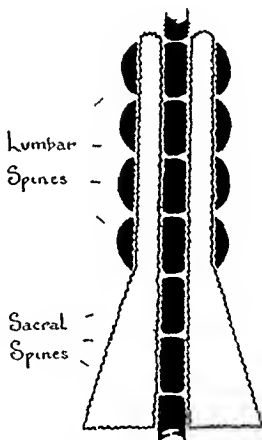


FIG 85 Diagram of fish tail grafting

as the dorsal plate is often very thin and sometimes incomplete. For this reason it is very dangerous to use a chisel blind on the back of the sacrum and the first step is carefully to expose the whole area of dorsal plate to be prepared. First one side is exposed and picked then the other. One makes the most of such spines as there are then flakes up the dorsum as described.

III Convalescence

The patient gets up when radiographs show that the disease is arrested and the region recalcified. Adults can usually come off the frame or plaster bed three or four months after operative posterior spinal fusion. They can

then roll over in bed and should spend several hours each day in the prone position in addition to periods of erector spinae exercises. When radiographs show satisfactory posterior synostosis and their dorsal muscles are thoroughly



FIG 86a



FIG 86b

strong, they can begin getting up for an hour or so. But sun or air baths must not be given up or relaxed. This is the time to drive home the benefits of treatment and make them permanent! The period of hospital ambulatory treatment will vary with the home conditions to which the patient returns on leaving hospital. The patient is first seen at the end of one month and then at gradually increasing intervals until the interval is one year. Yearly visits are then maintained.

The criteria for discarding the support and resuming work are the patient's general condition, X ray evidence of complete recalcification and of the strength of the graft, and the nature of his occupation.



FIG 86c



FIG 86d

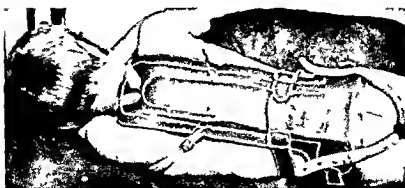


FIG 86e

FIGS 86a b c d e Light spinal support. The patient has a severe but fairly well compensated dorso lumbar kyphos. This is so prominent that a felt pad cut and grooved to fit it has to be applied. Over this is placed the light spinal support which has been prepared on a plaster cast with a hollow over the kyphos but with its contours arranged that when it is firmly strapped on the pelvis and resting on the kyphos the upper part stands away from the body.

Children, when the prolonged conservative treatment, which they need has led to the restoration of health and the production of reasonable orthopaedic stability coupled with recalcification, are allowed up gradually, with a support as for adults. This support is worn for some years and even, if considered advisable, throughout the growth period.

There is a proportion of cases in children over 8 or 10 in which spinal fusion must be considered on account of instability. In some, the degree of destruction alone, in others, a lateral displacement, make a graft synostosis desirable as a safeguard before they leave hospital. In others, one can wait and review the situation from time to time. Spinal grafting in younger children is of far less value and hardly ever indicated.

The conical splintage varies in type with the site of the lesion and in period with the age of the patient, the extent of severity of the lesion and the protection afforded by grafting.

Cervical, upper and mid dorsal region—spinal support with collar

Below mid dorsal region—spinal support (see Figs 86 a-e)

N.B. In children, if there is any lateral instability, the support has moulded leather lateral wings stiffened by duralumin strips.

Children wear their supports during the day till adolescence and then only remit them if there is really good spinal stability. Adults, after spinal fusion, wear supports just as long as radiographs and clinical judgement indicate, usually for at least six months, oftener a year, in order that the new bone may be trabeculated and its strength may be developed to meet all reasonable strains.

The Problem of Doubtful Arrest

From time to time one is faced with a patient who comes up with a long history of occasional pain, who is perhaps in good employment, and who appears fit and well. Not long ago the author saw a man of 29 (Case A.C.H.) with the following history:

Eight years ago when in the Air Force (transport driver) he went through a course of physical training and began to suffer from a pain in his back. This has recurred at intervals. Worse in winter than in summer. Has been able to work, play cricket, &c., all the time. Pain readily relieved by rest. On examination looks well and feels well. No local tenderness. Slight diffuse mid dorsal kyphosis. Small amount of localized muscle spasm. Touches his toes readily. X rays show two old foci of tuberculous disease (Fig 87), one about D 7-9 and the other D 12-L 1. There is little destruction of bone and the lesions do not look active. There is a suggestion of subperiosteal disease with upper and lower limits indefinite. The A.P. view shows a long fusiform abscess shadow.

In such a case what is one to advise? The problem calls for a thoughtful balancing of all the factors of the person, his living and working condition, the security of tenure of his work, together with an assessment of the degree of arrest and orthopaedic stability of his spinal lesion.

In cases where there is much angulation from localized destruction, the indications for decubitus and bone grafting are obvious. The problem is mechanical and can be solved by good joinery. Within six months the man



FIG 87a Radiograph of Case ACH



FIG 87b ACH—Same case



FIG 87
Figs 87c, d, and e illustrate the patient's normal appearance in a range of movement



FIG 87c

should be fitter for work than he is at the moment and his employers can generally be persuaded to keep his job for him over a definite period

But there may be another problem

Disease without identifiable upper or lower limits

A study of Figs 87a e leaves one with grave doubts on these points. In complete grafting is worse than useless, for extra strain is imposed on the



Fig 87e

spinal segments just above and below a synostosed section. Case ACH presents both these problems admirably. The man is in a good job—and the author is going to allow him to continue under observation, but will take care to ensure that he is well fed, has long nights, and extra holidays on the coast.

TABLE 7
Age Incidence Table

1-10	11-20	21-30	31-40	41-50	50+
81	44	93	52	24	19

This table of 319 cases of tuberculous spines includes both those treated conservatively and those treated conservatively plus operation.

TABLE 8

<i>Site of lesion</i>		<i>No of vertebrae involved</i>	
Cervical	13	Disk only	5
Dorsal	97	1	32
Lumbar	88	2	130
Sacral	1	3	66
D lumbar	65	4	18
L sacral	22	4+	19
Periosteal	1	Periosteal	3
	287	Double lesions	5
			278

The disparity between the two totals is due to 9 untraceable patients

TABLE 9

189 Cases with Conservative Treatment+Operation

<i>(a) Site of lesion</i>		<i>(b) No of vertebrae involved</i>	
C =	3 = 2 per cent	Disk only =	5 = 2.00 per cent
D =	56 = 30	1 =	18 = 10
L =	59 = 31	2 =	87 = 46
S =	1 = 0.50	3 =	42 = 22
D L =	50 = 26	4 =	18 = 10
L S =	19 = 10	4+ =	6 = 3
No not known =	1 = 0.50	Periosteal =	1 = 0.50
	189 = 100 per cent	Double lesions =	4 = 2
		No not known =	8 = 4
			189 = 100 per cent

N B No of vertebrae involved accurately recorded in 96 per cent

(a) shows the frequency of occurrence of lesions in the various regions of the spine

(b) shows the number of vertebrae involved at the time of the commencement of treatment

TABLE 10

Number of Vertebrae and Results

(Operative series continued)

<i>No of vertebrae</i>	<i>No of cases</i>	<i>Well</i>	<i>Unsatisfactory</i>	<i>Died</i>	<i>Incomplete</i>	<i>Untraced</i>
Disk only	5	3		1	1	
1	18	6	3	4	5	
2	87	42	7	18	19	3
3	42	25	2	5	10	
4	18	12	1	1	2	2
4+	6	5				1

1 periosteal—not active—well

4 double lesions 1 untraced

1 well

2 incomplete

8 no not known

Table 10 shows results as analysed in relation to the extent of the lesion

In referring to results no case is included in any group as a result that has not been followed or reported on at least five years after the termination of active treatment. 'Well' means that the patient is able to lead a normal life without any complaint referable to the tuberculous

lesion or its complications. Unsatisfactory includes all cases that have any residual complaint such as discharging sinus appreciable degree of deformity paraplegia &c

The mortality rate includes as far as possible only those who died as a result of the tuberculous lesion. There are however a few cases in which the cause of death could not be accurately determined and these have been included. The mortality rate from the disease is, therefore if anything slightly lower than the figures indicate.

The cases classed as Incomplete are those who at the time of the analysis were undergoing active treatment or were incomplete by reason of the fact that they were less than five years past the stage of active treatment.

Untraced are those cases in which either from our own records or with the help of the Tuberculosis Officer we had not been able to determine the condition of the patient at least five years after active treatment.

TABLE 11
Associated Lesions
(Operative series continued)

No of cases	Additional lesion	Results
9	Pulmonary tuberculosis	3+meningitis (died) 1+hip (died) 2 died 1 incomplete 1 lesion still active 1 well
5	Meningitis	1+renal (died) 1+epididymo orchitis (died) 3 died
2	Wrist	2 well and working
1	Renal	Died
3	Knee	2 well and working 1 incomplete
4	Hip	2 well and working 1 unsatisfactory, 1 incomplete
1	Trochanter	Unsatisfactory
1	Shoulder and epididymo orchitis+peritonitis	Died
1	Ilium amyloid	Died
1	Foot tarsus	Well and working
2	General tuberculosis	2 died
1	Orchitis	Died
2	Ankle	1 well and working 1 untraced
1	Elbow	Unsatisfactory

N.B. 34 cases with more than 1 lesion out of a total of 189

Table 11 shows 34 of the operative series of tuberculous spines which were complicated by other active lesions. The frequency of occurrence of the additional lesions are shown and also the results of treatment.

TABLE 12
(Operative series continued)

Results	1-10	11-20	21-30	31-40	41-50	50+	Totals
Well and working	29	19	40	24	7	5	124 = 65 per cent
Untraced	2	2	7	4	0	0	15 = 8
Incomplete	6	1	5	1	1	1	15 = 7
Unsatisfactory	1	0	3	1	2	0	7 = 4
Died	3	1	12	5	5	2	28 = 16
	41	23	67	35	15	8	189 = 100 per cent

Table 12 shows results in 189 cases in which operative procedures were an integral part of treatment. Only laminectomy or costotransversectomy and spinal fusion have been included as forming an integral part of treatment.

The age indicated is that at which the patient was first seen and only approximately 10 per cent of the first group were operated on before 10 years of age.

TABLE 13

130 Cases with Conservative Treatment only(a) *Site of lesion*

C = 10 =	7.50 per cent.
D = 41 =	32 "
L = 29 =	22 "
S = 0 =	0 "
D L = 15 =	12 "
L S = 3 =	2 "
Periosteal = 1 =	0.50 "
No. not known = 31 =	24 "
<hr/>	
130 = 100 per cent	

(b) *No. of vertebrae involved*

1 only = 14 =	14 per cent.
2 = 43 =	44 "
3 = 24 =	25 "
4+ = 13 =	14 "
Periosteal = 2 =	2 "
Double lesions = 1 =	1 "
<hr/>	
97 = 100 per cent	

N B In approximately 80 per cent of these cases is the extent of the lesion now accurately available

(a) shows the frequency of occurrence of lesions in the various regions of the spine

(b) shows the number of vertebrae involved at the time of the commencement of treatment

C = cervical, D = dorsal, L = lumbar, S = sacral, D L = dorso lumbar, L S = lumbo-sacral

TABLE 14

No. of Vertebrae and Results

(Non operative series continued)

<i>No. of vertebrae</i>	<i>No. of cases</i>	<i>Well</i>	<i>Unsatisfactory</i>	<i>Died</i>	<i>Incomplete</i>	<i>Untraced</i>
		<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
1	14	50	.	29	7	14
2	43	55	5	23	9	7
3	24	30	4	33	12	21
4	13	54	15	75	75	15

Table 14 shows results as analysed in relation to the extent of the lesion

TABLE 15

(Non operative series continued)

<i>No. of cases</i>	<i>Additional lesion</i>	<i>Results</i>
9	Pulmonary tuberculosis	7 died, 1 well, 1 unsatisfactory
4	Meningitis	Died
5	Miliary tuberculosis	Died
3	Peritonitis	Died
2	Ankle	Well
2	Knees	1 died, 1 well and working
2	Hips	1 died, 1 unsatisfactory.
1	Great trochanter	Well
1	Shoulder and elbow	Untraced
1	Elbow	Well
1	Symphysis pubis	Well

N B 31 cases with more than 1 lesion out of total of 130

Table 15 shows 31 of the cases of tuberculous spines treated by conservative measures alone, which were complicated by other active lesions. The frequency of the occurrence of the additional lesions are shown and also the result of treatment.

TABLE 16
(Non operative series continued)

<i>Results</i>	<i>1-10</i>	<i>11-20</i>	<i>21-30</i>	<i>31-40</i>	<i>41-50</i>	<i>50+</i>	<i>Totals</i>
Well and working	23	10	18	7	6	5	69 = 53 per cent
Untraced	3	2	1	3	0	0	9 = 7 "
Incomplete	8	1	0	0	0	0	9 = 7 "
Unsatisfactory	0	1	4	0	1	0	6 = 5 "
Died	6	7	9	7	2	6	37 = 28 "
	40	21	32	17	9	11	130 = 100 per cent.

Table 16 shows results in 130 cases in which conservative measures only were used, and these are classified into age periods

CHAPTER VIII

THE KNEE

TUBERCULOSIS of the knee is always secondary to active tuberculosis elsewhere, and almost always arises from long established infection of the lymphatic glands, and, though this primary lesion may have been present for a long time, the occurrence of the metastatic focus in the knee is proof that it is active and that from it tubercle bacilli are reaching the blood. Tuberculosis of the knee is seldom fatal, rather is it evidence of an infection which is often fatal and operative treatment of the knee, however necessary, and however successful, is applied to the flower and not to the root of this infection. Yet, with the flower gone, it is easy to forget the root, for with the removal of the focus in the knee goes the only obvious reason for the prolonged general treatment, yet this alone will keep the patient safe until he has killed or imprisoned all the tubercle bacilli in his body.

This point has been stressed here once again because the knee is excised oftener and earlier than any other joint. Early excision without adequate after care is futile surgery, and a very poor service to the patient.

PATHOLOGY

Site of infection

There is little or nothing to be added to the general grouping described above (p. 5). The disease may develop and behave as one of synovial infection, or, on the other hand, it may be clear from X ray evidence that the joint has been infected through visible osseous foci. It will be seen that osseous infection has an unfavourable bearing on prognosis in children.

Synovial arthritis.

That the infection of a knee by tuberculosis may be synovial alone has been demonstrated many times at operation. For the surgeon, while excising a knee and aiming at a total synovectomy, inspects completely the articular surfaces of femur and tibia.

When preparing a paper on tuberculosis of the knee for the Association of Surgeons in 1932¹ the author asked a number of his experienced colleagues 'Are there any data or conclusions as to the occurrence of purely synovial tuberculosis of the knee, its histology, and its prognostic significance?'

Now, 38 out of 41 colleagues who answered this question agreed as to the existence of purely synovial infection, and most added that the outlook is relatively favourable. Only 3 out of the 41 said either that synovial tuberculosis always goes on to osseous, or that minute osseous foci always exist round the synovial edges. The latter point is of no practical importance, it

¹ 'The Pathology and Treatment of Tuberculosis of the Knee joint' *The British Journal of Surgery*, vol. 19, 1932, no. 75.

suffices us to know that, in young children, if no bone cavities can be seen throughout a series of radiographs, and if these cases are treated well enough and long enough, the majority will recover with full movement. Soutter, of Boston, with 9 synovial cases out of 45, reported 3 with full movement, 3 with fair, 3 with unsound ankylosis. Fraser reported that of his synovial cases 17 per cent had free movement, 56 per cent had limited movement, 21 per cent some form of ankylosis, and that 6 per cent subsequently came to excision. The author's own results are as follows:

TABLE 17

Children with Non focal Tuberculosis of the Knee Treated and watched for 5 years or more at the Wingfield Morris Orthopaedic Hospital

Result	No of cases (14)	Period since set free from all splintage or restraint (1 year)
Full movement	9	2½ 4 6½ 2½ 2 3 3½ 2½ 9½
Good movements (i.e. 180° to above right angle)	2	3½ 3½
Under test	1	Free promising but time insufficient
Still under treatment	1	Promising
Excised sound union	1	

TABLE 18

Details of the 9 Cases with Full Movements shown in Table 17

Age	Plaster spica	Caliper and guarding plaster	Caliper only	Total period of splintage	Period since set free
(Years)	(Months)	(Months)	(Months)	(Years)	(Years)
1 9	7+5 = 12*	6+36 = 42*	23	6½	2½
2 2	20	13		2½	4
3 11	9	21	18	4	6½
4 1½	7	15	7	2½	2½
5 3	4+10 = 14*	5+9 = 14*	9	3	2
6 1½	36	4	27	5½	3
7 9	8+8 = 16*	4+8 = 12*	21	½	3½
8 12	12	9	4	2	2½
9 7	8	1½	1½	1½	2½

* Two periods—second due to signs of commencing reactivity after removing guarding plaster in each case.

† Owing to defective notes these time periods cannot be ascertained.

‡ B. All children with reasonably good homes become out patients during the second period.

Arthritis with osseous foci (for extra articular foci, see p. 160)

When a bone focus has opened through the articular cartilage into the knee the best result obtainable is ankylosis. Such a conclusion appears almost inevitable in view of the morbid anatomy, for while an endosteal focus can be encapsuled, it is necessary, in order to make the wall effective, that the focus be completely surrounded by healthy granulation tissue.

Often, of course, the joint is entirely destroyed and replaced by infected granuloma. But even in cases with limited foci, which at first sight are far more favourable, sound capping of the opening into the joint is seldom possible. It is true that if the opening is away from the weight bearing surface it can be capped by adhesions, but these will limit movement, and the security of the cap is endangered by a sudden wrench.

Fusion alone can give permanent security. In this type of case any hope of obtaining safe and permanent healing with good mobility, has always been forlorn, and the great majority of the author's correspondents agreed that such hopes are futile. He put the question 'Can you give any evidence of the healing of an osseous tuberculous focus, which has opened into the knee, with retention of a freely mobile joint?' Of 40 who answered this question, 35 answered definitely 'No', and some added 'I don't believe it ever occurs'. Calve said, 'I do not know of any case of an osseous focus opening into the joint with restoration of normal mobility. The invasion of the joint is always followed by ulceration of cartilage and then by definite loss of articular function.'

All these considerations lead to the conclusion that a tuberculous knee with bony foci communicating with the joint (see Fig. 89) should be excised, and the arthrodesis should be performed at a time chosen in view of the age and the general and local condition of the patient.

DIAGNOSIS

Only prompt, effective, continuous, and prolonged treatment will prevent synovial disease from becoming osseous. Yet the nature of the disease is such that an early certain diagnosis is often impossible, therefore we must put up with a *provisional diagnosis* and act on it as quickly and stringently as if it were final. Actually diagnosis and treatment must for a time run concurrently.

Tuberculosis of the knee is characteristically a monarticular arthritis with a very insidious onset. Generally the first thing noticed by the patient or parent is an interference with function rather than pain. Indeed, the characteristic initial feature is the limitation of the full range of movement in a swollen, warm, and somewhat tender and painful joint. The enlargement is due more to infiltration than to fluid. Inquiry may reveal (1) the likelihood of human infection, (2) previous manifestations of tuberculosis, (3) some loss of health and vigour, (4) a history of an injury to the knee from six to twelve weeks previously, with a normal joint during most of the interval.

But in early cases it is impossible to make a diagnosis in the out patient room. We must therefore be content with a *provisional diagnosis*, for we cannot wait for the development of a conclusive clinical or radiographic picture. An uncertain diagnosis is no excuse for hesitant treatment. On the contrary provisional diagnosis must be followed immediately by full-dress

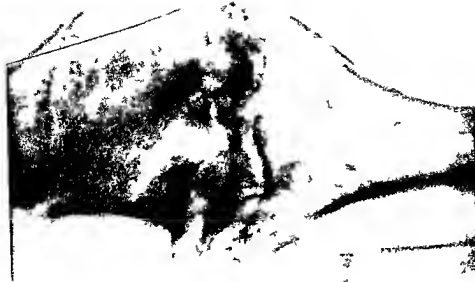


FIG 88b

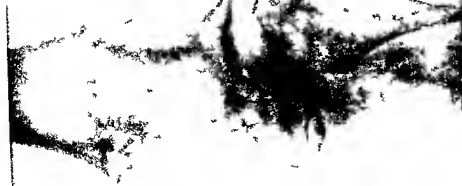


FIG 88a

FIGS 88a and 88b. Man aged 50 years, with a long history of recurrent attacks of gout and swelling for over 50 years. He ultimately broke the femoral shaft, which was amputated and replaced by a prosthetic limb. The limb was amputated and replaced by a prosthetic limb.



110 80 D.H. Woman age 129 4 years 1 story of rheumatism Very hot and swollen Very little painful movement
 X-rays show in 11 plates cases 2 feet in 11 a two or three obviously communicating with joint cavity

treatment This has been the author's practice for a long time, and its value has been proved, for in children under 10, without X ray evidence of osseous foci, early and very long continued immobilization has led to a complete cure with full movements in the majority of cases There had been a drift toward the feeling 'they will all come to excision sooner or later We now know that this is untrue—good news which encourages us to feel that our efforts toward the earliest possible provisional diagnosis and prompt admission are fully justified A provisional diagnosis of tuberculosis should be made on what is no more than a suggestive clinical picture whether radiographs reveal pathological changes or not the knee should be immobilized at once, and the patient admitted without delay for general treatment and investigation The standard general and local treatment is begun and the confirmation of diagnosis proceeds on the lines already described

Differential diagnosis.

For full discussion the reader is referred to Chapter VI One or two points specially concerning the knee may be mentioned

Seddon¹ reports that the removal of one or more of the femoral group of inguinal lymph glands has given good results, and it is his opinion that in most cases in which diagnostic operation was indicated this minor operation can replace arthroscopy with advantage

Again, the sub infected arthritis, which in the hip is 'transient' in name and nature, is often far from transient in the knee This may be due to anatomical differences Whereas the hip is a deep seated, deep socketed joint, protected by large muscular masses the knee is superficial, and particularly exposed to twists and strains Its muscular protection has little margin of safety, it is only adequate when at full strength Every sort of arthritis is quickly associated with muscular wasting with the result that the joint is at the same time inflamed, over sensitive and unprotected, and without its normal muscular protection, a vicious circle which may prolong an arthritis almost indefinitely after its exciting cause has disappeared Curiously enough mere standing about, or even sitting with the knee unsupported, will worry a knee which has been arthritic and has not yet regained full muscular powers The treatment therefore, of an observation knee has to be rather longer and more protective than in the hip, and followed by a rehabilitation of the joint by graduated exercises

Then, too, from its exposed position, the knee is peculiarly liable to recurring haemorrhage in haemophilia with subsequent gradual development of a chronic arthritis

The symmetrical arthritis of congenital syphilis (Clutton's joints) is also to be remembered in that the knees are far more commonly affected than any other joint Furthermore the two sides are by no means always simultaneously affected, so that the diagnostic symmetry may not appear

¹ Personal communication to the author



Fig 90 a

Figs 90 a and b H H Fos t v nat o decade sent o
 suggest ve of tuberculous



Fig 90 b

Pat ant age 145 8 veel a after se e v n l ry Extremely



I o 90c I o 90d
 FIGS 90c and 90d Same case a year later Clinical picture not mentioned here

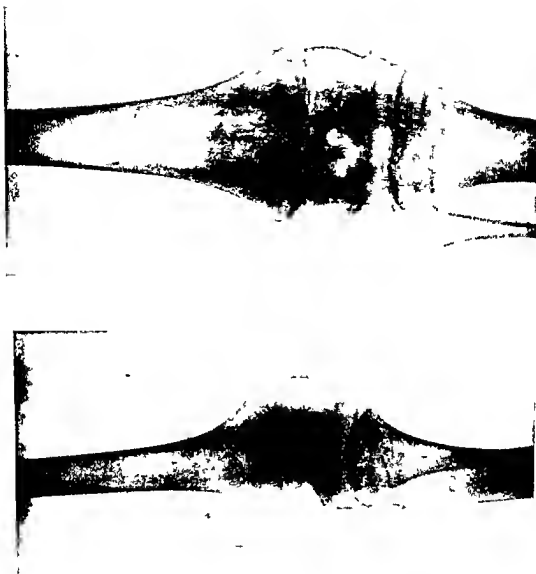


Fig 91a
Fig 91b
Figs 91a and b DM Boy aged 11 Septic arthritis of knee showing early ankylosis



FIG 92a and 92b Same case as Fig 91 3 years later Showing sound ankylosis (NB the knee is too straight the epiphyses are unaffected and will be subject to great strain, there is grave danger of back knee developing)

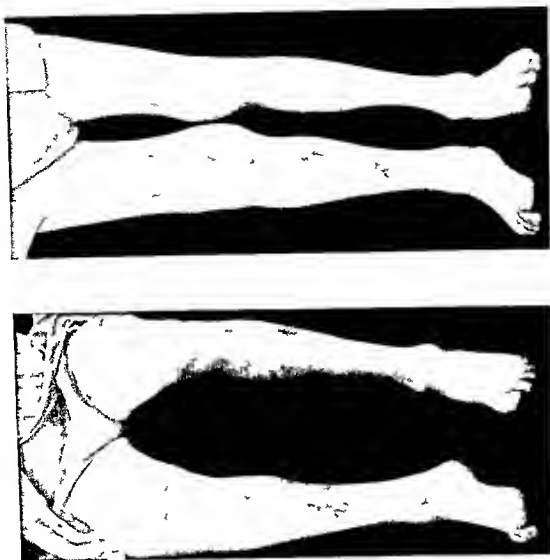


FIG 93a



FIG 93: a 1 b C/a col po t

FIG 3b



Figs 93a and b Clinical photographs of Figs 93a and b



FIG 94b



FIG 94a

Figs 94a and b G P Osteoarthritis

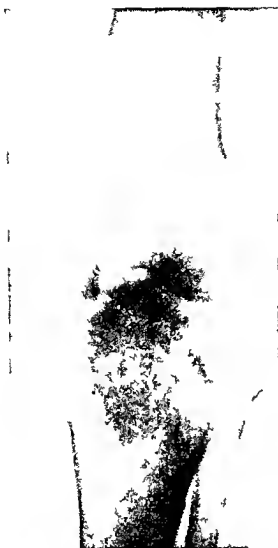


Fig. 90. Rheumatoid arthritis

General

TREATMENT

As the patients suffer from tuberculosis of which the knee is only one and the less dangerous lesion they all need general treatment by physical rest and metabolic stimulation heliotherapy a well chosen and varied diet and cheerful environment

In adults this general treatment is preparatory to operation but it is wise to explain to the patient that the operation will not lessen the need for continued general treatment and prolong after care. Indeed it is very doubtful whether after early middle age the glandular disease ever heals quite soundly for the readmission of the elderly patient with some new tuberculous metastasis a year or two after excision or amputation is more the rule than the exception. Clearly these elderly patients are unfit to

withstand any hardship and need specially favourable home conditions. This often presents a very difficult problem.

Local conservative treatment.

The local conservative treatment consists in keeping the joint comfortably and completely at rest. Any heat or disturbance, notably diathermy or massage, applied to the joint is extremely harmful. As to the methods of immobilization, so long as the joint is warm, and indeed for some months afterwards it should be *completely* immobilized, and the best method for this period is a plaster spica including pelvis and foot (see Fig 96).



FIG 96 Plaster spica giving complete rest to the knee

Deformity due to soft tissue changes can be corrected gradually by cutting and wedging the plaster. Fixed deformity can be left for the time and corrected later when excision is performed.

In young children, then, some months after the knee has become cool a weight bearing caliper with a guarding plaster can be applied, and before long the child allowed up (Fig 97). Later the guarding plaster can be left off but the weight bearing caliper must remain for years (Fig 98). In tuberculosis of the knee, permanent and disabling limitation of movement is much more likely to result from setting the knee free too soon than from retaining a weight bearing caliper needlessly long. With 'synovial disease, immobilization for years does not lead to fixation, whereas too brief

immobilization or a break in its continuity, is liable to lead to extension and reactivity of the disease, and thus to destruction of the articular cartilage and the loss of all hope of physiological mobility. In children permanent loss of movement is the result not of immobilization, but of disease. A study of several series of radiographs of 'synovial' tuberculous knees has convinced the author that the articular ends of the femur and tibia develop almost normally during the years of immobilization and protection from weight bearing. Movement returns of itself gradually and progressively if the knee is only set free after the disease is soundly healed.

The gratifying results which are being obtained by conservative treatment in children with synovial tuberculosis of the knee are due to the effective, uninterrupted and long continued splintage, which protects the synovial

membrane from movement and the articular cartilage from weight-bearing friction.

In children, a knee which has been the subject of synovial tuberculosis should be kept in a weight-bearing caliper for a long time, probably at



FIG. 97. Weight bearing caliper and guarding plaster

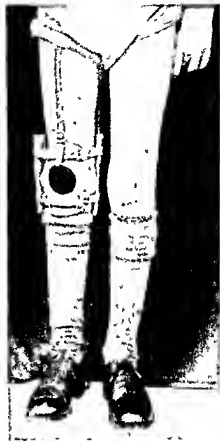


FIG. 98. Weight bearing caliper.

least a year, after all signs and symptoms of activity, such as warmth, swelling, and tenderness, have disappeared

ADULTS

Operative Treatment

(a) Middle-aged.

The primary splintage is a pelvis to foot plaster, as in children, windowed in front of the knee. Excision is carried out when the knee is cool and less swollen and when the patient is on the up-grade. For the bearing of other lesions on the indications for excision see p. 27.

Occasionally, however, one finds that neither patient nor knee shows any sign of improvement. This may be an indication for excision or amputation, if the toxæmia from the knee is the main cause of persistent and increasing illness: or it may be just part of a general breakdown of the resistance of the

body to tuberculosis. In some cases it may be extremely difficult to judge in what proportion the local and the general disease share the responsibility for the failure in recovery, and therefore whether radical operation is indicated or not.



Fig. 99 P.P.

Extra-articular foci.

Now and then it may be possible to eradicate a tuberculous focus close to the knee which has not infected it. But it is a very doubtful pobyey to attempt the eradication of a focus which, though apparently extra articular, has already set up irritation of the joint. The author is more and more convinced that irritation of a joint does not occur without its infection (see p. 6). This, if it be true, means that there is nothing to be gained by making an attempt to eradicate such a focus by an extra articular approach, and perhaps some risk, for if a tuberculous sinus forms and is allowed to become infected pyogenic infection of the joint may supervene. In a young child, then, it is best, when an apparently extra articular focus is associated with signs and symptoms of arthritis, to wait awhile with full local conservative treatment, then, if it

becomes clear that the focus is not in communication with the joint, and if interference is indicated, it can be curetted by an extra articular route. Perhaps either immobilization or protection from weight bearing may be advisable for a time, the former will be indicated by signs of synovial irritation and the latter by X ray evidence. Finally the patient can be set free and put through Thomas's tests.

But in a patient over 14 years of age there is no need to wait, an operation can be performed. If there is no communication well and good, but if such a communication is found, or if the tuberculous infection of the joint is proved by the subsequent progress, it can be fused before the risk of secondary infection arises.

Figs. 14 (P.P.) and 15 (D.G.) illustrate two cases of extra articular foci. In

P P the focus was erased (Fig 99) by an extra articular route. In D G an abscess formed, it was aspirated and a sinus developed which remained uninfected and healed. P P has been walking with full free movement since June 1936 and his knee may be regarded as completely cured. The other



FIG 100 D G

boy is beginning to leave off his caliper progressively with good prospects of full free movement.

Excision, erosion, arthrodesis

There are only two safe end results for a tuberculous knee—free movement or bony ankylosis.

Sound healing with free movement is not obtainable in adults, and in children only to be sought when the disease appears to be synovial.

In adults, then, ankylosis is the aim, this necessitates operative arthrodesis, for natural sound ankylosis does not occur, and anythings hort of it is unreliable

In view of these axioms fusion is indicated in all cases of proved tuberculosis of the knee joint, except in children without radiographic foci communicating with the joint, and in cases in which it is contra indicated by age or complications

The modern operation, whether it is called excision, erasion, fusion, or arthrodesis, is designed

(a) To remove all diseased parts which are accessible without either interfering with growth or lessening the prospect of bony ankylosis

(b) To promote bony ankylosis

The dangers of the operation are listed later. In the main they are due to operating on cases unduly early, unduly young, or with infected sinuses. There is also the danger of forgetting the root because the flower has been cut!

Indications for excision 1 *After confirmation of diagnosis* by clinical progress, a series of radiographs, or laboratory tests including in some cases the finding of tubercle bacilli or typical histology in a regional gland or in perisynovial granulomatous tissue

It has already been explained that arthrotomy is only to be done when the knee is ready for excision, it can then be the first step of the excision, or, if microscopic evidence is needed, can precede excision by a week or two, i.e. a time too brief for the establishment and possible secondary infection of a tuberculous sinus

2 Excision is the standard practice for patients aged 15 to 50

3 *Stage in treatment when excision is performed*

(a) In adolescents and adults Only after the general illness and local activity have been checked by general treatment and immobilization

(b) In children with radiographic osseous foci Only when the conservative treatment is complete and the patient is old enough—10, 12, 14, 16—opinions differ

(c) In children without radiographic osseous foci Only after radiographs have revealed damage to the articular surfaces and the patient is old enough

Technical points 1 *Tourniquet and towelling* A tourniquet is valuable for the earlier stages of the operation but it should be removed for haemostasis before any sutures, grafts, pegs or nails are applied. The tourniquet makes the operation easier for the surgeon and the patient loses less blood and is less exposed to toxæmia and perhaps bacillaemia. The towelling should be well folded and clipped round the limb above and below the knee so that the leg is 'stockinged' and the thigh 'trouserred', otherwise gaps appear when the knee is fully flexed during the operation

2 *Division of ligaments* After removal of the suprapatellar pouch the complete division of the medial, lateral and crucial ligaments facilitates the posterior synovectomy. the posterior capsule is 'cleaned' and left intact

In adults the infected soft tissues should be completely removed, both because they are tuberculous and therefore capable of preventing osteogenesis and thus frustrating fusion, and because the disease of the soft tissues may persist even after successful arthrodesis. Remember Robert Jones's dictum

'In adults treat tuberculous tissue as if it were malignant disease'! But in children the operation, having been postponed to adolescence, generally comes at the end of long conservative treatment, all the signs of synovial inflammation have long ago disappeared, and there is now no point in formal synovectomy. Any thickened synovial membrane is removed, the cartilage of the articular surfaces is shaved off, and if any osseous foci are present they are thoroughly scraped out with a sharp spoon. But there is no need to level the bone down to the bottom of these excavations, and indeed to do so is thoroughly wasteful and wrong. The surfaces are prepared with the general aim of removing the *least amount of bone possible*, in order to maintain length and of bringing into contact large mutually adapted areas of vascular bone, in order to promote rapid and strong union.

In the author's view the knee should never be straight: he believes that an angle of about 130° is a fair average for an adult. The angle is chosen to suit the sex and occupation of the patient. Flexion favours sitting, at work, in motor bus, train, church and theatre, and with the flexion balanced by a raised heel, the patient can walk almost as well as with a straight leg.

Removal of tourniquet. The tourniquet should be removed as soon as the bone surfaces have been prepared, and in any case should not be kept on more than thirty minutes. All bleeding points are then tied or fixed.

Internal fixation. Most surgeons who cut the bone ends square use some form of internal fixation. Favourite methods are decussating bone pegs or long nails which project from the plaster and are removed as soon as the plaster is set, or several weeks later. Some use the rawed patella, this is not recommended because if one removes very little bone it must be used as a free graft, and indeed a desire to use it tempts one to remove too much



FIG. 101 Showing end result of excision.
Position of choice for average use.

and set the knee too straight. Hinged osteoperiosteal flaps from femur, tibia, or both, are mentioned by some writers.

But by the ball-and-socket method apposition is easily maintained, and slight accidental alteration of the angle of flexion does not interfere with the area of bony contact, so that there is little need for internal fixation or grafting.

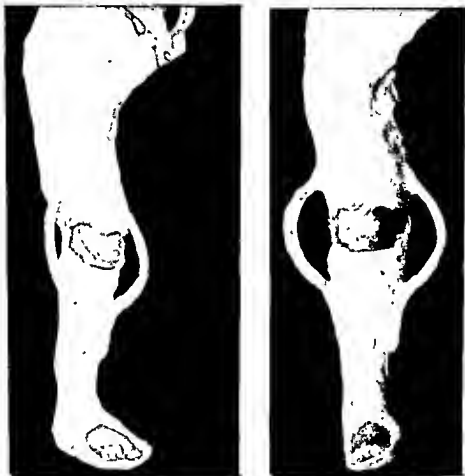


FIG 102 Plaster spica showing flying buttresses

Drainage for twenty-four hours is advisable

Method of immobilization. A plaster spica including pelvis and foot is almost universally used, though a few surgeons still prefer the Thomas's bed splint with gutter adaptation splints. Flying buttresses of plaster or ferro-plaster enable one to cut in outline at once a large window removable (and replaceable) for dressing the wound and removing the drains (Fig 102).

Length of immobilization. It is wise to leave the patient in the spica for ten or twelve weeks, then use a guarding plaster, with a caliper flexed to fit (Fig 103) until radiographs show sound union

Great care must be taken to avoid imposing any angular strain upon the

union until it is solid. Some axial compression is however beneficial and the caliper need not be weight bearing. Union is seldom sound before six months.

Possible sources of failure. Fusion is by no means automatic but sound clinical judgement followed by skilful operation and accurate splintage will ensure a very high percentage of success.



FIG. 103 Guarding plaster with caliper flexed to fit

Failure may be due to

1. Operating while the disease is active, the patient ill and the local resistance so poor that local tuberculous recrudescence takes place.

2. Active tuberculosis elsewhere, making the patient too ill to produce union despite the absence of local tuberculous recrudescence. (One such case has occurred at the Wingfield Morris Hospital, the patient ultimately succumbing to phthisis a year or more after the operation.)

3. Pyogenic infection from poor technique or a pre-existing infected sinus. This is a major disaster but avoidable by good technique and by regarding an infected sinus as a contra-indication of excision. In the presence of such a sinus amputation is far preferable to excision which would expose the patient to a very grave risk of widespread infection of a wound very ill adapted for drainage and peculiarly prone to give rise to pyaemia.

4 Ineffective immobilization allowing displacement during the period between the end of the operation and the completion of the plaster or mobility afterwards

o Operation done unwisely on a very young patient is almost sure to fail (a) from lack of bony union because the ossific nuclei in the epiphyses are relatively small (b) because secondary deformity develops from the unusual strains thrown on the young weak bone laid down on the metaphyseal side of the growth disk or (c) from the classic error of the past—namely interference with growth from a too radical operation resulting in damage to one or both disks. The author has a girl of 20 under his care—she was operated on elsewhere while a young child—the growth disks were damaged and her leg is 7 inches short.

Contra-indications to excision

- 1 Childhood
- 2 Persistent illness with fever and toxæmia
- 3 Active phthisis
- 4 Extensive involvement of the femoral shaft
- 5 Active septic infection of sinuses despite preparatory drainage or free exposure scraping and packing. This fifth contra-indication may be eliminated by preliminary radical excision and saucerization of the infected sinuses.

The drainage should be thorough and one or other modification of Winnett Orr's technique should be adopted in preference to the use of tubes. If skilful and radical measures fail to lead to the healing of the sinuses due probably to inaccessible pockets amputation is in the author's opinion infinitely preferable to excision because more conclusive and far less dangerous in such circumstances.

RESULTS

The author asked his correspondents for their experiences as to the percentage of bony ankylosis after excision. Henderson of the Mayo Clinic reported 194 excisions with bony ankylosis in 171 cases (88 per cent). Putti recorded 104 cases with 66.6 per cent of bony ankylosis. 26 other correspondents have returned figures (mostly estimated) and these averaged 87 per cent. The author's own series of operations done by his colleagues and himself comprises 26 cases with sufficient interval since operation to furnish end results with 88 per cent of sound bony fusion. There were 3 failures—one was a middle-aged woman ill with a superadded pyogenic infection—the second was a middle-aged man with phthisis who died from that condition between one and two years afterwards—the third an adolescent whose joint had been very extensively destroyed has a sound fibrous but not bony ankylosis—he has been hard at work for more than three years and there is no clinical or radiographic sign of tuberculosis. In the remaining 23 cases sound bony ankylosis resulted. Of the 3 failures 1 is a relative suc-

cess, and in the other 2 cases the author now feels that excision was contra-indicated

The author does not know of any case in which excision has led to tuberculous dissemination. Doubtless that danger is minimized by the preliminary conservative treatment and the use of a tourniquet at operation.

Excision of the knee comes out of the inquiry with an excellent reputation. It should, of course, be reserved for cases in which we know, from the type of the disease or from the age of the patient, or after failure of a prolonged trial of conservative measures, that it is futile to hope for movement with sound, safe healing. But although a soundly ankylosed knee compares poorly with a normal joint, it is far better than a thigh stump.

Amputation.

To the author's question, 'What do you consider the indications in the age-groups 0-14, 15-50 and 50 upwards for amputation?' Elmslie's answer was representative: 'Amputation under 14 only when the case does very badly with conservative treatment. Young adults only when doing badly under conservative treatment and if the bone disease is too extensive for excision. Older people in any case are unsuitable for excision.'

One may say that *amputation is indicated only when either the patient or the limb has otherwise little prospect of recovery*. This means that amputation is indicated rarely. It should be reserved for the patient who is very old or very ill, or for the knee which is very extensively diseased or heavily infected with pyogenic organisms (see Table 20).

TABLE 19
Knee Operations

47 cases

Synovectomy + excision—26 cases

Average age 24 years

symptom period 2 years (one case 32 years)

Results 21 cases—firm fusion in satisfactory position

1 case—not firm 9 months after operation (last note)

1 —died of pulmonary tuberculosis 7 months after operation

3 cases—incomplete

Arthroplasty followed by synovectomy + excision—10 cases

Average age 21 years

symptom period 2 years

Results 7 cases—firm fusion in satisfactory position

2 —unknown

1 case—incomplete

Synovectomy alone—1 case

Result good mobile joint

Amputation—9 cases

Average age 44 years (excluding the 2 year old child)

symptom period 12 years

Results 8 adult cases 7 cases satisfactory

1 case—pain phantom limb type, necessitating chordotomy

1 case aged 2 years satisfactory (amputation done for severe secondary infection)

Anterior wedge osteotomy—1 case for excess flexion

Result firm fusion in satisfactory position

TABLE 20

*Amputations for Tuberculosis of the Knee, Wingfield Morris
Orthopaedic Hospital*

	<i>Age</i>	<i>Reason</i>	<i>Result</i>
1	26	Very extensive pyogenic infection of fixed flexed knee	Good for a year or more but subsequently developed lesions in spine and rib, still under treatment
2	39	Active phthisis	Good
3	60	Age Recrudescence of disease after 52 years	Good, except for pain of phantom limb type
4	57	Age	Good
5	36	Extensive pyogenic infection	Good
6	2	Active extending secondarily infected disease and general illness threatening life	Good
7	44	Active phthisis	Good
8	48	Chronic phthisis	Good
9	30	Long history Severe extensive pyogenic infection	Good

Sir Robert Jones has taught us that in a patient past middle age tuberculosis must be dealt with almost as radically as malignant disease. In deciding between excision and amputation one takes into account the relative senility of the patient and the extent and activity of the disease. There are very few patients whom Osler would have found 'too old at 40' for excision, and some, perhaps who are too young at 60 for amputation. The author thinks Freiberg conveyed a useful hint when he said 'We feel that amputations are probably not done often enough in patients beyond middle age'. But the author would not be fair to his correspondents if he did not express their abhorrence of avoidable amputation.

Sinus formation.

There is a vast difference between a tuberculous sinus and a sinus secondarily infected. A tuberculous sinus will, as a rule, close quickly if the general and local treatment is good. So long as it remains it is a danger because it exposes the knee to the risk of pyogenic infection, and this catastrophe can only be avoided by very careful antiseptic dressings (see p. 25). A tuberculous sinus should never be probed!

Arthroplasty.

The author asked a further question 'Has arthroplasty any place in the after treatment of tuberculosis of the knee?' 32 of the 44 answers were decided negatives. Fairbank underlined his 'No' four times, and Culve said 'Criminal'! Very convincing, too, is a plain 'No' from Putti, probably the greatest exponent of arthroplasty of the knee.

There remained 11 who gave a qualified assent to the idea that an arthroplasty might possibly be warranted under exceptional circumstances—for

example, as Willis Campbell pointed out, when first one knee has had to be fused and later the other has suffered in the same way. Their argument was that the particular circumstances of the case might possibly warrant an arthroplasty of the first knee provided the time interval and radiographic appearances justified it. On the other hand Willis Campbell himself, in reporting a series of 57 cases of arthroplasty for ankylosis, gives an analysis of the origin of the ankylosis and not one was tuberculous. A joint destroyed by a very slow and wasting disease offers poor material for arthroplasty. A sound ankylosis of the knee in good position is very much better than a poor arthroplasty, and for a working man or woman, incomparably better.

The fibrous ankylosis following conservative treatment is seldom permanently safe from recrudescence, and time alone does not bring safety. An example of this is furnished by a case of the author's in which tuberculous recrudescence occurred moderately from time to time and finally, severely, fifty two years after the original attack. Taking everything into consideration it is fair to say that in fibrous ankylosis following tuberculosis arthroplasty is unsafe, and after bony fusion definitely undesirable. Clearly then, there is no justification for arthroplasty in tuberculosis of the knee.

SUMMARY

Pathology.

Tuberculosis of the knee is a dual disease—an outspoken lesion in the knee arising from another deep, unseen, and much more dangerous lesion.

Cases can be classified into three groups by the topography of infection, and again into three groups by the age of the patient, and each group calls for a different line of treatment.

Three groups distinguishable by radiographs

- (a) '*Extra articular*' With osseous foci which appear to be extra articular. The question of radical elimination of these foci by an extra articular route is discussed, and Calvé's warning considered.
- (b) '*Osseous*' With bone foci communicating with the joint. Reasons are given for the decision that the joint should be fused, and the arthrodesis performed at a time chosen in view of the age, local and general conditions.
- (c) '*Synovial*' Without foci that can be seen in radiographs. In such cases in young children there is good hope of recovery with full movement after very long continued immobilization (see Tables 17 and 18).

Three groups distinguishable by the age of the patient

- (a) *Young children* 0-10, for whom prolonged immobilization is indicated, but neither diagnostic operation nor fusion.

¹ Willis Campbell, *Surgery, Gynecology and Obst.*, 1929, July, 89.

- (b) *The adolescents and adults 15-50, for whom immobilization is preparatory to confirmation of diagnosis by arthrotomy, followed by fusion (rarely, for particular reason, by amputation)*
- (c) *The elderly, from 50 onwards, for many of whom amputation is commonly wiser than fusion*

Diagnosis.

Provisional diagnosis, coupled with immediate treatment, is the first step, after which for a time treatment and diagnosis run concurrently. In young children indeed, a *clinical diagnosis*, carefully tested and reviewed, is sufficient.

Reasons are given for the conclusion that *diagnostic arthrotomy* is contra-indicated until the patient reaches an age when a positive diagnosis of tuberculosis will be quickly followed by fusion. The difficulties and risks of arthrotomy are discussed and a definition of its indications is suggested.

Treatment.

General A combination of physical rest and metabolic stimulation serves to restore the vitality of the patient, and to raise it to a high level. This level should be maintained through the months or years of lymphatic disease and tuberculous bacillaemia. And the care must not be lessened or its period shortened because the knee has been fused.

Local There are only two safe end results in tuberculosis of the knee: free movement and bony ankylosis.

The aim of local treatment, then, is the restoration of full movement, and, failing that, bony ankylosis. Immobilization is the paradoxical method of restoring movement.

Operative fusion is discussed, its rationale, its indications, its technical points, its contraindications, and its failures. Figures are quoted. On the whole it is highly successful, but should be avoided in those too young, too old, too ill, or obstinately septic.

Amputation has a restricted field as a life saving measure for those disqualified for fusion by illness, age, or sepsis. Outside this field it is unanimously condemned.

Arthroplasty has no place in the treatment of tuberculosis of the knee or its results, for it is almost always either unsafe or impracticable.

CHAPTER IX

SACRO-ILIAC JOINT

TUBERCULOSIS of the sacro iliac joint may be an isolated lesion affecting one, or rarely both, sacro iliac joints, or it may occur as one among several tuberculous lesions in the same patient

In 140 cases recently investigated by Seddon,¹ the disease was apparently confined to the sacro iliac joint in about 50 per cent, accompanied by other tuberculous lesions in the remaining 50 per cent

TABLE 21

Total no	118	Mortality 2 years after onset of disease	26.7 per cent
<i>Analysis of mortality rate is as follows</i>			
Isolated lesion without sinuses			— 4.6 per cent
Isolated lesion with sinuses			— 20.3 per cent
Sacro iliac tuberculosis with lesions elsewhere (Chiefly lung spine or kidney in that order) and with or without sinuses			= 50.0 per cent
<i>Author's note: The influence on the mortality of sinuses is great and of the other lesions very remarkable</i>			

The disease occurs most commonly in young adult patients. Of 35 Oxford cases there were none in the first decade, 9 in the second decade, 13 in the third, 9 in the fourth, 1 in the fifth, and 3 in the sixth.

The lesion is usually situated in the subchondral bone of the lower half of the sacro iliac synchondrosis. The upper part of the articulation is seldom affected initially, and even in the later stages the disease rarely spreads to this region.

As in the case of many other joints, the cartilage is undermined and lifted by the formation of tuberculous granulation tissue, and thus deprived of its blood supply is sloughed off into the joint. The neighbouring ilium, and to a less degree the sacrum, are liable to infiltration and necrosis, not infrequently with the formation of sequestra of fair size (Figs 104 a and b), later perhaps progressive bone destruction often results in the formation of an abscess, and the pus may track forward under the iliopectors and point in the groin, or backward, forming a fluctuating swelling behind the joint. Finally, if there is no arrest of the disease, the joint becomes completely disorganized, and the abscesses break down, forming sinuses which, if secondarily infected, constitute a most intractable form of chronic suppuration and are likely to require most radical drainage.

DIAGNOSIS

The onset and early progress of the disease is often insidious and practically symptomless, so that patients may present themselves for examination with abscess formation already present.

¹ Personal communication.



FIG 104a V S Man aged 24 Tubercular disease of left sacro iliac joint with sequestra
Abscess left buttock—aspiration impracticable Pus thick and fibrinous Operat on
x 37—excis on of sequestra
X ray v u 37 shows appearance before operation



FIG 104b Same case 3 months after operation

Pain localized to the affected joint is usually present though often not of great severity and there may be tenderness on palpation of the joint behind. But the point is very noteworthy. Kernig's test and hyperextension, compression or rotational strains applied to the joint are often unprovocative of pain at any stage. If an abscess is present which has passed beyond the confines of the joint, fluctuation will be detected in the iliac fossa or behind the joint.



FIG. 103. W.J. Some months after operation for secondary infection of left sacroiliac joint. Showing removal of hole posterior superior spine region of ilium and the back of the sacroiliac joint. Prolonged suppuration associated with secondary infection. Result—sound healing.

Radiographs of this joint should always be stereoscopic. They show in the early stages blurring of the outlines of the joint and decalcification of the adjacent bone. In more advanced cases there is radiographic evidence of destruction of bone and sometimes sequestra may be seen (Figs 104 a 106 a and b). The lower part of the joint is more often attacked than the upper and the ilium more often than the sacrum.

Provisional diagnosis

As in the hip patients with early symptoms and signs suggestive of tuberculous should be admitted under a provisional diagnosis more especially so if they are ill. In disease of this joint the restoration of health of the patient is a matter of greater urgency than the local treatment of the joint for two reasons: first because the prognosis is good if no other lesion



FIG 106a E.T. Girl aged 20 Tuberculosis of right sacro iliac joint with sequestrum on



FIG 106b Same case 1 year after modified Verrall grafting

or complication exists or arises secondly because the movement of this joint is always negligible

Differential diagnosis

1 **Acute arthritis** The sacro iliac joint may be the seat of acute inflammation due in most cases to a blood stream infection by the *Staphylococcus aureus*. The disease is characterized by sudden onset severe pain and tender



FIG. 107 R.H. Acute septic arthritis

ness of the affected joint and constitutional disturbance with high fever. Suppuration may follow or the inflammation may subside without pus formation. Radiography shows no change in the early stages. Later there may be some evidence of local destruction or reaction in one or other neighbouring bone and if the whole joint becomes infected destruction of the joint surfaces leading to ankylosis but long before this abscesses will have formed and required incision and a bacteriologist's diagnosis will have been made.

2 **Subacute and chronic arthritis (including rheumatoid arthritis)** This condition may closely resemble tuberculosis of the sacro iliac joint clinically but is more frequently bilateral. The usual complaint is of pain localized to one or both sacro iliac joints. This is of a constant aching character often more severe than in cases of tuberculosis and more easily elicited or exacerbated by the usual test strains applied to the joint. The diagnosis can sometimes be made by X rays which may show some loss of the normal clear joint outlines not necessarily confined to the lower part of the joint and perhaps a layer of hypercalcification on the sacral or iliac side. The condition may be

mon articular or part of a poly articular rheumatoid arthritis and like other joints the condition may be toxicæmic or due to a low grade infection which never goes on to suppuration

3 Osteoarthritis This is seldom confined to one sacro iliac joint being more often part of radiologically obvious lumbar and lumbo sacral hyper



FIG 108 W T Male Showing the typical vacuolated appearance of both sacro iliac joints and commencing fusion of the inter lumbar lateral articular ones

trophic arthritis The X ray signs age incidence and clinical picture distinguish them from tuberculosis

4 Spondylitis Rhizomelique The sacro iliac joints seem to be constantly and early affected in this curious and disabling disease The sacro iliac disease is much more insidious and less painful than the spinal manifestations and the sacro iliac signs and symptoms are overshadowed by the ankylosing spondylitis which may affect the whole spinal column and major joints especially the hips Radiographic changes in the sacro iliac joints appear early and are always bilateral (Fig 108) They take the form of a mottling of the bones constituting the joint a rapid melting away of the cartilage so that before long the whole joint line has disappeared The wide

spread nature of spondylitis rhizomelique and its characteristic tendency to cause progressive and rigid ankylosis of the affected joints soon become apparent and there should be no difficulty in differentiating it from sacro iliac tuberculosis

5 New growths Sarcoma or deposits of secondary carcinoma may affect the lateral mass of the ilium in close relation to the sacro iliac joint and give rise to symptoms and signs not easily distinguishable from tuberculosis of the

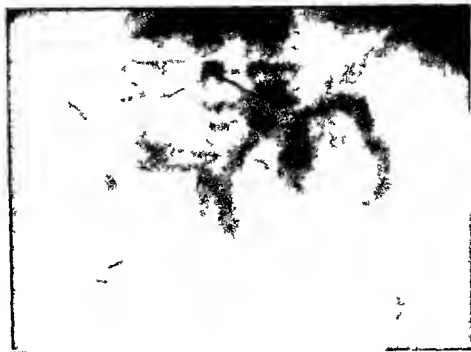


FIG 109 R F Man age 45 Extensive destruction of left sacro iliac joint by rounded tumour

joint. A soft tumour may simulate an abscess with false fluctuation but so soft a tumour will usually give palpable pulsation and the diagnosis is made clear by the characteristic radiographic appearances (Fig 109)

6 Sacro iliac strain or subluxation This common condition may resemble early sacro iliac tuberculosis. There is usually however a history of injury or strain the pain is at times much more severe and more variable and comes on in attacks with relative freedom between them and radiography shows a normal joint. It is aggravated by any sort of strain and the pain is of a type different from the deep seated quietly persistent aching of tuberculosis. The great point of distinction however is the sharp pain elicited by straining the sacro iliac joint. It is impossible to give a more specific account of the group of conditions traumatic anatomical sometimes complicated by toxæmia which are included in the term sacro iliac strain.

Operative diagnosis.

The author has no hesitation in recommending arthrotomy whenever real doubt remains after treatment under provisional diagnosis. By this time the diagnosis will rest between subacute (? rheumatoid) arthritis and tubercle with perhaps tumour.

The lower end of the joint is exposed by a rather miniature posterior Smith Petersen incision. In doing this great care is exercised in the introduction of the end of a long, strong, blunt dissector into the top of the sciatic notch, it must be pushed down along the ilium and round into the notch in close contact with the bone. This protects the sub gluteal artery. Arthrotomy is completed by removing enough of the posterior part of the iliac contribution to the lower end of the joint.

TREATMENT

General.

As soon as a provisional diagnosis has been made the patient should be admitted to an orthopaedic hospital without delay. Here he is brought under the regime already described in detail elsewhere in this book. If the diagnosis is established the standard general treatment, which has already been started, will be continued. But operative fusion probably plays a larger part and takes the stage earlier in this joint than any other, again for two reasons: because there is no question about fusion being the best possible end result and secondly there is no adequate ambulatory external splintage. Therefore after a sufficient period of general treatment and local immobilization on a frame or plaster bed, some form of operative arthrodesis is carried out. The preparatory treatment usually occupies at least three months, during this time the patient's general health is restored and his vitality raised, as evidenced by the improvement in his appearance and appetite, the absence of night sweats and the stabilization of temperature records. Conservative treatment will, of course, be continued if there are contra indications to fusion.

Local.

In order to obtain the necessary complete rest both for the patient and his local lesion, he is placed, as soon after admission as possible, on a Jones spinal frame or on a plaster bed. The former is preferable, for it allows more complete exposure of the patient's body to the air, wind, and sky.

If a purulent abscess is present it is treated by aspiration, repeated as often as may be necessary. If the contents will not pass through a 'Gauvain' cannula, the abscess may be opened and thoroughly evacuated by a muscle splitting incision just above Poupart's ligament. The wound is sutured, and the skin painted with the blue dye (p. 25). If the wound breaks down and a sinus forms it will heal as long as secondary pyogenic infection is prevented by careful antiseptic precautions in the dressing of the wound. If the abscess is pointing posteriorly, it is treated on the same lines, the patient being turned

periodically by means of the turning case to allow the necessary aspiration operation or dressing to be carried out

When the prescribed period of general treatment has elapsed operative synostosis should be performed in almost every case of sacro iliac tuberculosis. The presence of a psoas abscess or uninfected sinus is not a contra indication to operation provided that the patient's condition is satisfactory in every other way. And it is permissible in some cases to do posterior extra articular



FIG. 110. Woman aged 34. Eight months after double Verrall graft.

graft fusion even with an infected anterior sinus. A posterior abscess or sinus on the other hand does in the author's opinion preclude operation unless it can be avoided and in these cases aspiration or surgical drainage must be continued till no fluctuation can be detected or a sinus is healed.

Opinions differ as to the best method of fusing a tuberculous sacro iliac joint. In America both the Smith Petersen and Campbell types of operation are frequently performed. At Berck sur Mer advantage is taken of the fact that the disease most often involves the lower half of the joint and the upper portion is fused by an intra articular peg graft or Smith Petersen operation.

The author's practice is to fuse the joint by the extra articular method of Verrall modified by the introduction of a second graft on the affected side only more or less parallel with the first and usually of only half the length passing subperiosteally between the sacral spines and the ilium just below the posterior spine.

The operation is done with the patient lying prone on the turning case as in the cases of spinal fusion. The grafts are introduced by means of three

short incisions, not by turning down a large flap as in the original Verrall technique. A short straight incision is made in the mid line over the upper sacral spines, and these are exposed and stripped laterally so as to expose the posterior surface of the sacrum and ensure by direct vision that the grafts pass across at the correct level, i.e. under the sacral periosteum and through the bases of the spinous processes. Two curved lateral incisions are made in the form of brackets (), one on each side, so as to expose the ilium at the level of the posterior superior spine. By means of long bladed narrow gouges or chisels the ilium is tunnelled deep to the posterior superior spine, and the instrument worked across the posterior surface of the sacrum, passing through the bases of the sacral spines and into the opposite ilium. This operation is only free from danger if the greatest care is taken in preserving the back of the sacrum. The layer of bone protecting the sacral canal is often extremely thin, and here traction with damage to the sacral nerves is only too easy. The author feels that whenever grafting, whether vertical or, in this case, transverse is applied to this region, the preparation of the raw bed should be carried out as much as possible *under direct vision*.

In the application of the Verrall graft one should aim at applying the endosteal surface of the graft to the prepared raw surface of the sacrum and under the raised and fragmented sacral spines. One must always be on the look out for spina bifida occulta, which in the form of posterior sacral defect leaves the cauda equina exposed to damage. At the lower level the instrument is only passed just beyond the base of the sacral spine, which it penetrates. Two fairly stout pointed grafts of the requisite length are then cut from the left tibia, and hammered home along the previously prepared tracks.

After operation the patient remains immobilized on his frame or plaster bed for a further period of at least three months. Then, if the radiographs show satisfactory fusion of the grafts, he is taken off his frame, allowed a short period of freedom in bed with massage and exercises of the muscles of his limbs and back, fitted with a strong sacro iliac belt of the Mennell¹ type, and gradually allowed up. After discharge from hospital the patient is kept under regular observation at a clinic with periodical X ray checking. The belt may usually be discarded at the end of a year or two, if radiography shows satisfactory fusion and arrest of the disease.

In cases where secondary infection of sinuses has occurred, resulting in a hectic type of temperature, chronic profuse suppuration, and loss of weight and deterioration in the patient's general health, a very radical drainage operation offers the only chance of preventing amyloid disease with its inevitable ending.

The joint is approached by a posterior incision directly over it and a large wedge of iliac bone removed, sufficient to allow free access to the joint cavity. All pus sequestra, caseous matter, and necrotic bone and cartilage debris are removed and the walls of the cavity curetted till healthy vascular bone

¹ Mennell James, M.D. *Backache* J and A Churchill Gloucester Place, Portman Square, 1931.

is reached. Here, as in the hip (pp 91 and 92), the recesses of the joint should be thoroughly saucerized. The cavity is then packed with linen impregnated with vaseline, which is left in place for the first three or four weeks, then changed at infrequent intervals.

TABLE 22

Non operative End-results

(Length of time since treatment not known)

Results	1-10	11-20	21-30	31-40	41-50	50+	Totals
Well and working		1	1	2			4 = 40 per cent
Untraced		1					1 = 10
Incomplete							=
Unsatisfactory				2			2 = 20
Died				1		2	3 = 30
		2	1	5		2	10 = 100 per cent

Table 22 shows the results of conservative treatment alone of 10 cases of tuberculosis of the sacro iliac joint. The number of cases in each decade is also indicated.

TABLE 23

Operative End results

Types of treatment	No of cases	Results				Unsatisfactory
		Well	Died	Untraced	Incomplete	
Double Verrall graft only	20	6		4	10	
Smith Petersen graft only	1				1	
Double Verrall + I A A * + Smith Petersen	1				1	
Smith Petersen + peg graft	2	2				
Smith Petersen + Double Verrall graft	1				1	

Table 23 shows the various types of operation used in 25 cases of tuberculosis of the sacro iliac joint and the results obtained.

* The intra articular procedures are infrequently employed and then only in doubtful cases for diagnostic purposes.

I A A = intra articular arthrodesis

TABLE 24

Operative End results

Results	1-10	11-20	21-30	31-40	41-50	50+	Totals
Well and working		6	6	2			14 = 56 per cent
Untraced		1	2				3 = 12
Incomplete		3	1	2		1	7 = 28
Unsatisfactory							
Died		1					1 = 4
		11	9	4		1	25 = 100 per cent

Table 24 shows the results of conservative + operative treatment of 25 cases of tuberculosis of sacro iliac joints.

CHAPTER X

ANKLE

TUBERCULOSIS of the ankle is not uncommon. The clinical picture is similar to that of the hip or knee, and, as in these joints, the condition may be primarily synovial or osseous. Radiographs may reveal an 'extra articular' focus in the tibia above the epiphyseal or bone foci communicating with the joint plate (Figs 111 *a* and *b*) or in the astragalus.

DIAGNOSIS

This follows exactly the process which has been described in regard to the hip and the knee. The provisional diagnosis of observation ankle will again often be found useful, and there is nothing additional to be said in regard to differential diagnosis.

TREATMENT

General.

The treatment is standard.

Local.

1. *Conservative Prolonged immobilization.* The opinion has been expressed that some form of metal splint, e.g. the Thomas claw splint, is preferable to plaster—and even that abscess formation is less likely with this form of splintage. The author much prefers the better and more continuous immobilization afforded by plaster. During the conservative treatment of tuberculous arthritis of the joint the caution regarding heat must be remembered and care taken to avoid the plaster being exposed to the sun. Lack of this precaution may well promote reactivity of disease for which the plaster may be unjustly blamed.

If there is any suggestion of abscess formation the plaster should be split to allow an occasional inspection and aspiration if necessary, a window will suffice for this if the abscess is localized. The greatest care (p. 25) should always be taken to avoid secondary infection of a sinus, both by careful preparation of the skin with the special paint before, and at each dressing after, its appearance. Aspiration should always be tried, but will seldom be effective in this region. With the full precautions previously described free incision is permissible.

For the periods of splintage in children in observation cases, and for definite synovial and osseous disease, see the programme described for the hip and the knee. But there is one important difference in the later stages of treatment in that natural fibrous ankylosis is often stable enough to dispense with the need for arthrodesis. Many children recover with movement.



FIG 111 a

FIG 111 b

FIGS 111 a and b J S. Male aged 35. Three months history of pain and swelling. No radiographic signs origin ally. In plaster for 18 months—X rays show subchondral erosion with small but deepish communicating foci

2 Operative *Extra articular foci* When an opportunity of erasion of a tuberculous focus occurs it should be carried out by an extra articular route

Astragalectomy If the disease appears to be confined to the astragalus astragalectomy should be performed. Apart from these conditions treatment will depend upon the age of the patient. In children and adolescents conservative treatment alone in plaster is as a rule satisfactory. In adults if the tuberculosis is uncomplicated by secondary infection excision and *arthrodesis* is the rule. This is best carried out at or toward the end of the second stage of conservative treatment preferably when recalcification has begun but it can be done earlier if special reasons so indicate.

In older patients in whom the disease is progressive or the tuberculosis complicated by secondary infection *amputation* is indicated (see Figs 112*a* and *b*)

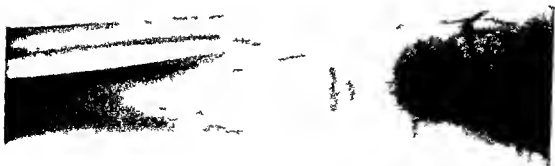
Technique

(a) **Astragalectomy** A tourniquet is used and the joint exposed through a curved incision on the outer side beginning behind the external malleolus and passing below it and up on to the dorsum of the foot. The peroneal tendons are retracted, the external lateral ligaments of the ankle divided and the joint completely opened in front, laterally and behind. The foot is now strongly inverted so as to dislocate the astragalus 90° outwards and the bone freed from its ligamentous connections with a gouge and knife and removed. In an early case in which disease is still limited to the astragalus great care should be taken *not to grasp the bone with strong bone holding forceps* which though they may aid extraction may also crush the thin shell of bone surrounding a tuberculous focus and set free infective material into the joint. Synovial membrane if infected is dissected away after removal of the astragalus and any foci in the tibio fibular mortise curetted. The foot is then displaced backwards so that the tibio fibular mortise bestrides the tarsus in the region of the calcaneo cuboid joint. The mortise must be widened slightly by removal of thin malleolar bone slices if necessary to accommodate the tarsus at this point (or the tarsus may be narrowed). The final fit should be firm and the foot plantiflexed about 10° to 15°. The tourniquet is removed, haemostasis obtained, the wound closed and plaster applied from just above the knee to the toes. This plaster is split immediately along the midline in front of the ankle to permit of subsequent spreading if post operative swelling interferes with circulation in the foot.

Astragalectomy can be made to give a satisfactory orthopaedic result especially in young children with a good prospect of freedom from recurrence. Calve¹ reports 12 mobile ankle joints out of 13 cases of early astragalectomy in young children (2-8 years).

(b) **Excision and arthrodesis** A tourniquet is used and a similar incision made as already described for the operation of astragalectomy. The fibula is divided obliquely with a fine chisel at the level of the ankle joint

¹ Cal & Jacques Personal Communication



1 to 11 a

1 to 11 a and b H T Valed aged 9

H story 10 months of pain and swelling
 this formation Perosteal reaction

1 to 11 b

X ray also a secondary infection on



and the external malleolar portion turned downwards hinging on the intact external lateral ligaments. This opens the ankle joint, and the capsule is divided well across to the inner side anteriorly and posteriorly. The foot is now forcibly inverted so as to dislocate the astragalus 90° outwards. This

is an essential step in order to obtain complete exposure of the ankle joint. The diseased synovial membrane is dissected away very thoroughly and all articular cartilage removed with a gouge (or if necrotic with a spoon) from the astragalus and the tibio fibular mortise special attention being paid to the inner aspect of the internal malleolus and the corresponding astragalus surface. The apposing bony surfaces are deliberately incised and roughened with a chisel or gouge. The cartilage is removed from the detached external malleolar fragment, the astragalus returned to the mortise by straightening the foot and the external malleolar fragment fitted back as a graft and pegged on to the astragalus with a bone nail. Before the pegging of the external malleolar fragment the foot should be held in the final position of some 10° to 15° of plantar flexion in order to fix the position of the ankle immediately. The tourniquet is removed, haemostasis obtained, the wound closed and plaster applied from above the knee to the toes. This is split forthwith as described for astragalectomy.



FIG 113 Thomas walking splint

Ambulatory treatment

After the active stage, and the need for general rest are over the patient can be allowed up in either a Thomas walking splint (Fig 113) with a patten on the other boot or if an adult on a knee flexion peg leg.

Result of treatment

This is satisfactory on the whole. Younger patients and individuals with out much involvement of bone when treated early may recover with mobile joints. Ankylosis more usually results. *Primary amputation* through the middle third of the leg has much to be said for it especially in adult wage earners with extensive disease. For conservative treatment alone or conservative surgery must mean at least two years treatment whilst amputation offers an earlier return to work with the additional advantage of complete elimination of this disease focus. But the associated lymphatic tuberculosis must not be forgotten (see Chapter I).

CHAPTER XI

TARSUS

TUBERCULOSIS of the tarsus occurs without much discrimination of age in the form of an insidious chronic inflammation with discomfort some swelling tenderness and warmth

As a rule the infection is fairly widespread but occasionally there are isolated foci particularly in the os calcis or astragalus

DIAGNOSIS

This is as a rule fairly straightforward from the clinical picture and from the radiographic evidence of decalcification which is locally rather wide spread with perhaps evidence of erosion

Differential diagnosis

This proceeds on standard lines The only particular local abnormality which could be mistaken for tuberculosis is Köhler's disease an ischaemic osteochondritis of the tarsal scaphoid (Figs 117 and 119) This is one of the many instances of ischaemic disturbance of a bone nucleus due to embolism or thrombosis of an end artery Radiographs show the characteristic narrowing condensation (hypercalcification) and often fragmentation of the ossific nucleus In any of these the ischaemia may be due to an infected embolus pyogenic or tuberculous (see p 43) Such cases are very rare and distinguished by clinical and radiographic progress

TREATMENT

The general treatment is standard and the local consists in immobilization of the whole foot and leg in a comfortable fitting plaster or splint The period of splintage and general line of treatment follow the principles which have already been fully described

Whenever there is evidence of localized disease of a single bone radical erosion of the focus or excision of the bone should be carried out and if the astragalus is extensively involved without infection of the ankle joint astragalectomy is indicated

The prognosis in tuberculosis of the tarsus or metatarsus depends almost entirely on the age of the patient In children the prognosis is very good Conservative treatment almost always leads to healing with a reasonably normal and painless weight bearing foot In middle age amputation will save years of confinement Amputation is almost invariably indicated in patients above 40



1 a 114a TS Mal n 5 a 118 Compl n g f pers stent po
n 1 s ell b h l n l pper loel Ra l g r a l s l s l l e f n e l
v i t l seq e tr u n



1 a 111b Sa de caso Afte ems on T B f n l



FIG 115 EP Tuberculous abscess



FIG 116 VC Tuberculous lesion in internal cuneiform



Fig 118



Fig 117

Fig 117 I W Ors nally s n dltol Kol ler s laseaso l at d o r e d a e m a
was l a c t o n t l b e r c l o s e m b o l i s

Fig 118 K T C l l l a g l s l n f a r t l o l a r l y s u a 2 y e a r s a t o T a s s
o f a f f e c t e l l m b

Fig 119 B S Kol ler s l a s a e

CHAPTER VII

METATARSUS AND PHALANGES

In the author's experience tuberculous disease of the metatarsus and of the phalanges is almost confined to young children and the prognosis is good



FIG. 120 March fracture

The local lesion is a relatively minor matter, except as evidence of deep seated lymphatic tuberculosis

DIAGNOSIS

Here again the picture is one of insidious inflammation with a little discomfort swelling warmth and tenderness added to this are negative Wassermann and positive Mantoux reactions

In these small bones sequestration is relatively common

Differential diagnosis

Here there are two local oddities to be borne in mind

- (a) March fracture (see Fig 120)
- (b) Osteochondritis of a metatarsal head (Fig 121)



FIG 121 Osteochondritis of metatarsal head

TREATMENT

Incision of an abscess under the strictest precautions (see p 25) with excision or erosion of diseased or necrosed bone is indicated and protection of the foot from weight bearing until some months after the last sign of active disease

In young children it is seldom that anything more radical than sequestrectomy and curettage is required. In adults however radical treatment is often preferable to prolonged immobilization particularly if loss of function of the infected part is inevitable.

CHAPTER XIII

SHOULDER

This condition is relatively uncommon. In the Wingfield Hospital there have been 13 cases, and in a recent report given at the Shropshire Orthopaedic Hospital of 2,922 cases of bone and joint tuberculosis there were only 27 cases in which the shoulder was affected. This is less than 1 per cent.

Morbid anatomy.

It is well known that the shoulder joint is a common situation for the atrophic type of tuberculosis, *caries sicca*, and this, in the author's experience, is rather more common in adults than the florid type with synovial thickening. In the former case the lesion is osseous, commonly superficial infiltration and erosion of the articular surfaces of the joint rather than deep seated osseous foci. In children, on the other hand, massive lesions are fairly common (Figs 121 a and b).

DIAGNOSIS

The clinical characteristics of a tuberculous shoulder differ markedly in the two types. In both the history is, of course, of the kind already described and the patients complain of loss of function rather than of pain.

(a) *Caries sicca* (Fig 122). The appearance of the joint is characteristic. The arm is held to the side and there is extreme wasting of the muscles round the shoulder, particularly the deltoid. The patient cannot raise his arm from his side and will seldom move the scapulo humeral joint at all. On examination there is almost complete limitation of all movement with perhaps a little warmth and tenderness.

Radiographically there is decalcification of, and lack of definition in the outline of the articular surfaces. Age incidence commonly the middle aged or the elderly.

(b) Synovial type (Fig 123). The characteristic features are swelling, warmth, tenderness, and pain.

The radiographic picture is that of decalcification without erosion.

Differential diagnosis.

As described in regard to the hip *q v*, perhaps special attention may be given to osteitis fibrosa (fibrocystic disease), osteoclastoma, and sarcoma, also traumatic arthritis, Codman's Shoulder,¹ and a subacute form of staphylococcal osteitis.

Staphylococcal infection. The author has on several occasions seen a very chronic form of staphylococcal osteitis of the neck of the scapula with

¹ Codman, E. A., 'The Shoulder', *Rupture of the Supraspinatus Tendon and other Lesions in or about the Subacromial Bursa*. Thomas Todd, Boston, Mass., 1934.



FIG 121a



FIG 121b

FIGS 121a and b DP a = 1x34 b = 1x35 Chf I aged 3
Subsequently secondary lesion developed in spine



FIG 122 Male aged 38 One year's history Pain particularly at night Shoulder fairly mobile till month before examination On examination wasted and immobile shoulder Radiographically unsound ankylosis



FIG 123 M/C Woman with 3 years' history following pleurisy



Fig 13, Synpl 1a



Fig 14 Osteo lasterna

general swelling round the shoulder, without much pain but with complete limitation of movement. Actually this is more likely to be mistaken for a sarcoma than for tuberculosis. At the same time it should be borne in mind whenever one is presented with an immensely swollen stiff shoulder



FIG. 126 Osteoarthritis

TREATMENT

General

As this is the first non weight bearing joint with which we have had to deal this perhaps is the most suitable place to discuss the problem of hospitalization. There are two schools of thought.

Some surgeons are of the opinion that general supervision of the patient's home conditions is all that need be undertaken.

Indeed some go so far as to allow the patient to be about at home and carry his arm in a sling. The author differs completely from this *laissez faire* point of view. As the reader will have already discovered, he looks upon every patient with a recent tuberculous lesion as seriously ill and needing general treatment for quite two years. This of course does not mean that the patient must always be retained in hospital but to begin with he should be admitted, put to bed and investigated thoroughly for signs of tuberculosis elsewhere including a study of his temperature chart. This also gives time to make sure of the comfort and efficiency of his local splintage. After this period his treatment will depend upon his home conditions and his health.

and vitality, but the author believes whole heartedly that it is our duty to do the utmost possible, by moving him to a favourable climate, particularly in the winter, and by inculcating a healthy regime of life

Children, in particular, should always be brought into the hospital, and that the full general treatment outlined on p 15 et seq should be instituted

Local.

The form of splintage found best by the author is a body and arm plaster (Fig 127 *a* and *b*) The more extensive the hold such a plaster has upon the body the more comfortable is the splint and the more effective is the immobilization The splintage is really built up upon the pelvis, and the weight of the arm is transmitted to a well padded firm hold of the pelvis A large anterior window can be cut out The arm is held in a position which is modified in accordance with the age of the patient In young children this is 90° abduction, 30° flexion, and about 20° external rotation, with the elbow at a right angle and the wrist supinated The hand is always much more comfortable if the plaster is carried well down to support its ulnar side

In adults, in whom the scapula is less mobile, the position is 70° abduction, 40° flexion, and as much external rotation as will ensure that flexion of the elbow will bring the fingers to the mouth

In young children more abduction and more external rotation can be allowed on account of the greater mobility of the scapula It is also probable that any fixation that occurs naturally will be fibrous and will tend to give way in the direction of adduction as time passes

Period of splintage.

(a) **Synovial.** In cases where the diagnosis is almost certain the splintage is continued without interruption for at least a year and always some months after the disappearance of all swelling and heat If, at this period, there is no radiographic evidence of osseous foci the lid of the plaster is removed and active and gentle passive movements encouraged The success of this treatment is judged by Thomas's standards (p 21) and if the results are encouraging a light aeroplane splint is substituted for the plaster and, week by week a further range of movements allowed

N.B. In cases where the diagnosis is 'observation shoulder' the whole process can be speeded up

(b) **Osseous** Here the period of splintage is governed by the radiographs The shoulder is a non weight bearing joint and not subjected to the great strains and stress of the knee and the hip One can therefore, particularly in children, be satisfied with a fibrous ankylosis which would be dangerous in a weight bearing joint Even in cases where there has been considerable destruction the splintage can be gradually remitted on the lines described above provided that the patient can maintain abduction It is this maintenance of abduction either by active movements or by the control of a



FIG 127a



FIG 127b

FIGS 127a and b Shoulder specia



FIG 127c



FIG 127d

FIGS 127c, d, e and f show range of movements after arthrodesis in position of choice



FIG. 127e.



FIG. 127f.

sound fibrous ankylosis which is the aim of splintage and which may call for continued splintage long after the disease has apparently been arrested. On the other hand in older children excision of the diseased soft tissues with erosion of the bone foci may have to be carried out and arthrodesis is frequently indicated. This may be achieved by some form of intra articular arthrodesis almost always associated with an extra articular osteoplastic or graft synostosis. After such an operation splintage in plaster is necessary for six months to one year and the position chosen will be midway between those described on p. 198 for children and adults.

The difference in the local treatment of adults is that arthrodesis is carried out at a much earlier stage. The general indications are the same as those for the hip and the knee in that it is advisable before operating to raise the general resistance of the patient and to reduce if possible the activity of the local disease.

In the florid form it is the author's practice in adults to carry out a thorough excision of diseased soft tissues the erosion of osseous foci and arthrodesis.

Technique of operation

1 Excision and intra articular arthrodesis. Incision. Skin flap turned up exposing deltoid. The deltoid muscle is detached widely with its periosteum of origin and turned down. The shoulder joint is opened the infected synovia and all the tuberculous granulations and debris removed.

The head of the humerus is remodelled with the object of producing the largest possible surfaces of healthy bone directed toward the scapula. Next the glenoid is cleared of cartilage leaving a vascular bony surface. The acromion is then carefully split well back into an upper and a lower leaf. The lower leaf is turned down in the form of an osteo periosteal bone flap to meet the upper edge of the glenoid with its raw surface toward the humerus.

The operation is then completed by fitting the adapted surface of the head into the socket formed by the acromion the pedunculated acromial flap and the glenoid. Close apposition must be maintained and it is possible to favour this by a suitable strong catgut suture to maintain the parts in apposition until the plaster has been applied.

The deltoid is sutured back onto its origin with chromic catgut and the skin wound sutured without drainage. The arm is put in plaster and joined to the body cast (applied before operation). Position 70° 40° .

2 Extra articular arthrodesis. (a) *Blatson Jones technique.* Exposure as above the joint capsule is not opened. The acromion is denuded of periosteum on the upper and lower surfaces. A cleft is made in the great tuberosity of the humerus by driving a chisel into it in the sagittal plane and levering the fragment out but not fracturing it off. The base of the acromion and the outer end of the clavicle is nearly cut through with a chisel so that the acromion can be angled down and its raw end impacted



FIG 128 Extra articular arthrodesis Watson Jones technique



FIG 129 Low arthrodesis Britain's technique Five months after operation

into the cleft in the great tuberosity when the arm is abducted to the required angle. The wound is closed and the plaster completed as above.

(b) *Low arthrodesis*. Posterior axillary arthrodesis. This operation was described to the author personally by Mr Brittain.

The approach is posterior and the method consists in placing a stout tibial graft with one sharp end impacted into the shaft of the humerus and one bifid end fixed against and partially mortised into the axillary border of the scapula. This is a low (distal) extra articular arthrodesis, and very closely analogous to the Trumble method of ischio femoral arthrodesis of the hip. The author has tried it in one case only, but feels that it is likely to prove a good method for those cases of healing tuberculosis of the shoulder in which a local excision is not necessary. It eliminates any risk of secondary adduction.

The elderly.

In the elderly the prognosis is poor and it is probably wise to leave the patient with his arm in a sling and to be guided as to operation by the activity of local disease. If the condition is a mild one there is fair hope that the inflammation may become quiescent, for a time at least, with a sling and good general treatment. If, however, there is a more florid type of disease, excision may become necessary, but operation should be avoided if possible.

These older patients are, as a rule, widely infected with tuberculosis: their physique and vitality rather than their years must be our guide, actually the humbler objective of a quiescent joint with the arm at the side—an arm which is often within reach by conservative measure—is generally preferable to excision and arthrodesis, because the excision with the after splintage is not easily borne, and the fusion will often fail.

Operations, with end-results

The following table shows the results of a series of 7 cases of tuberculosis of the shoulder treated by conservative plus operative methods in the Wingfield covering a period of 12 years.

TABLE 25

Var	M or F	Age	Length of disease	Type of operation	Result
G B	M	31	1 month	I A A + acromial flap	Fibrous ankylosis
A H	M	35	1 year		Fibrous ankylosis (died of meningitis 16 months after)
K K	M	16	1 year		Fibrous ankylosis Working
L M	F	23	2 years		Untraceable
A O	F	13	7 weeks		Firm fusion
M R	F	45		Excision of head and upper 2 of humerus	Very good Mobile
A S	F	38	8 years (approx)	I A A + acromial flap	Firm fusion

CHAPTER XIV

ELBOW

In a period of 15 years 16 cases of tuberculosis of the elbow have been treated at the Wingfield Morris Orthopaedic Hospital. But the elbow though a complex joint is relatively free from all forms of arthritis other than those following injury or occupational stress. So much so that an insidious non-articular arthritis of the elbow is more likely to be tuberculous than in most other joints. Furthermore the disease is commonly synovial in the sense that there are often no radiographic signs particularly in the first two or three decades of life. Curiously enough the elbow is very seldom subject to the transient arthritis associated with pharyngeal or intestinal infections during childhood and it is far less liable to that form of chronic non-tuberculous arthritis which is a common and stubborn affection of the wrist in young adults. So that on the whole any case of arthritis of the elbow of insidious origin must be regarded with grave suspicion and treated promptly and very carefully under a provisional diagnosis.

Morbid anatomy

If there are osseous foci in the neighbourhood of the elbow they are most often found in the ulna.

DIAGNOSIS

Here again the clinical picture is of standard type. In the young patient there are always swelling, warmth, tenderness and pain on movement with considerable limitation of its range by muscular spasm.

Differential diagnosis. Standard (*vide p. 39 et seq.*)

TREATMENT

General. Standard (*vide p. 17 et seq.*)

Local

1. In children and adolescents prolonged conservative treatment is almost always adequate.

Immobilization is provided by a plaster from shoulder to palm; a close fitting shoulder cap is necessary above and a cock up palm hold below in order to check radio-ulnar movements. The angle of posture should be a few degrees above that ultimately desired. This varies slightly according to the patient's occupation and wishes. One can begin with the elbow just above a right angle and the hand slightly pronated.

(a) In cases without radiographic evidence of tuberculosis in which the diagnosis remains *sub judice* the plaster is kept on for some months after the last sign of warmth, tenderness or swelling has disappeared and then

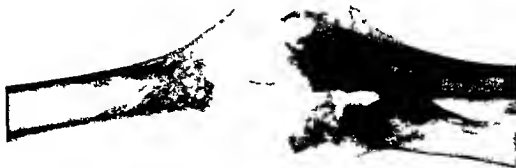


FIG 130a



FIG 130b

FIG 130a 16 TSB Male age 10 Extensive lateral elbow joint



FIG 131b

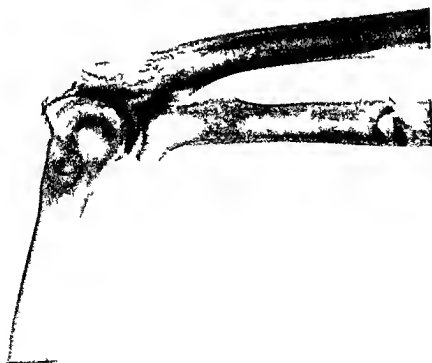


FIG 131a

FIGS 131a and 131b Male age 148 Osteoarthritis



1 to 132b

1008 132a and b Tertiary syphilis



1 to 132a

replaced by a sling. This is retained for a test period on the usual standard tentative plan. If movement progressively increases all is well.

(b) Whenever there has been disorganization of the joint one aims at bringing about sound fibrous ankylosis in children, but in adults, bony fusion by excision and arthrodesis.



FIG 133 Osteochondritis dissecans.

The angle of fixation must be chosen in view of the occupation of the patient and the service which he most desires from the affected limb. It varies between 80° and 110° .

II. In the middle-aged and elderly. (a) *Synovial*. Treatment is at first conservative as described above. But even if, at the end of a year or so, the inflammation appears arrested, immobilization must be kept up for a very long time, and it is well to replace the plaster by a moulded leather splint which may have to be worn almost indefinitely. If progress is less satisfactory excision and arthrodesis is advisable.

(b) *Ossseous*. Here again conservative treatment as above should be tried. But in cases in which clinical signs and radiographs suggest that the

main disease is osseous, a limited erosion and curettage of these lesions without wide exposure of the joint may be worth while, as an incident in the conservative treatment, and in the hope of eliminating the need for formal excision.

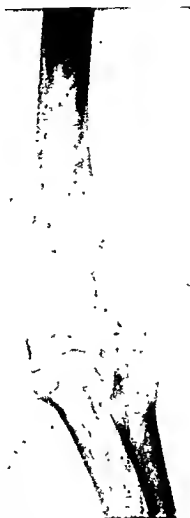


FIG. 131a F.K. Male, aged 21. Eighteen months' history, tuberculosis of elbow.

Excision and arthrodesis. Incision: a long curved postero-internal incision is made centred on the joint and beginning and ending in the midline behind.

The triceps is split and dissected off the condyles of the humerus, and the upper ends of the radius and ulna are cleared, keeping very close to the bone and taking the greatest possible care not to damage the ulnar nerve in its fibrous bed. The nerve is *identified though not fully exposed* and very carefully and gently retracted with its surrounding soft tissues out of the way with the least possible retractor pressure and without, of course, ever picking up or



FIG 134c

FIGS 134b and c. Same patient 4 years after excision of articular surface



FIG 134b

touching the nerve with the forceps In order to open up and expose the interior of the joint the posterior joint capsule and synovial membrane are dissected away and the elbow strongly flexed All pus debris and infected tissues are removed and all synovial pouches carefully dissected away, special attention being paid to the reflections round the neck of the radius The articular cartilage is removed completely from the humeral radial and ulnar surfaces This may require the use of a gouge but the cartilage often peels off readily with a curette The bone surfaces left above and below should be vascular and as broad and well adapted to each other as possible

A tourniquet has been used and this is now removed or released and haemostasis is obtained The bone ends are then fitted into close apposition with the elbow in the position of election, muscular aponeurotic and skin wounds are closed without drainage and plaster applied

CHAPTER XV

THE WRIST

THE author has had 15 cases in 18 years and Seddon told the author that in the last 14 years they had had only 12 cases in the Country Branch of the Royal National Orthopaedic Hospital

The morbid anatomy, differential diagnosis, and general treatment need not be restated formally, a few local considerations are dealt with below.

Various parts may be infected

- 1 The radio carpal joint
- 2 The inferior radio ulnar joint ¹
- 3 The carpal bones and intercarpal joints
- 4 The compound palmar ganglion—or other tendon sheaths

Synovial disease of the wrist presents a characteristic appearance, but diagnosis may be difficult because the wrist is prone to suffer from a peculiar form of arthritis of unknown origin (but of a 'rheumatoid' type) Thus, in its chronicity and its clinical picture, is only to be distinguished in that there is not the decalcification of tuberculosis It is very troublesome, even more chronic, and less likely to become quiescent than tuberculosis; and in such cases after, perhaps, a year or more of plaster immobilization, the surgeon is driven to one of two courses—either immobilization for an indefinite period in a reinforced moulded leather splint, or arthrotomy for diagnosis and, perhaps, arthrodesis The wrist is, of course, also commonly affected by the ordinary polyarticular rheumatoid arthritis.

Osseous disease. It is dangerous to be dogmatic regarding a relatively rare disease, but a widespread carpal infection seems common when the infection is evidently osseous

The carpal bones seem prone to tuberculosis in the elderly, and this is often of a very destructive type, with sinus formation and secondary septic infection The hand and wrist become swollen and burrowed by infected sinuses

The carpals, metacarpals, and phalanges are fairly commonly involved as part of that multiple small bone tuberculosis which occurs in young children particularly Here there is often relatively early abscess and sinus formation Fortunately these cases do well with general treatment, with perhaps an accent on heliotherapy

The inferior radio ulnar joint may be infected with the radio carpal joint (Fig 135) or, more rarely, be infected alone. Occasionally it is affected by that

¹ Liebolt (*Surg Gynec and Obst*, 66, 1938, 1008) has recorded a 30.4 per cent frequency of associated infection of the lower end of the ulna with that of the wrist joint in a series of 23 cases, and 30.6 per cent frequency of perforation of the triangular fibro cartilage in a series of 160 wrists examined p.m. He suggests that the fibro cartilage is ordinarily a protection against the spread of infection

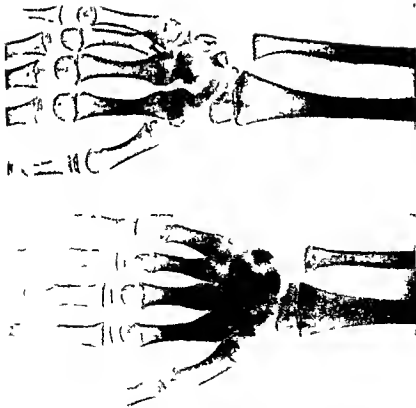


Fig 135 b

Fig 135 a

FIG 135 a B S P Boy aged 4 Extensive tuberculosis of the carpal bones involving bases of the medial four metacarpals Discharging sinus

FIG 135 b Same case 7 years later Revascularization and recstitution of carpal bones as a result of long continued general treatment

FIG 136 S A Male age 17 Four years' history Discharging sinuses X ray shows extensive destruction of wrist and carpal joints as a result of tuberculosis



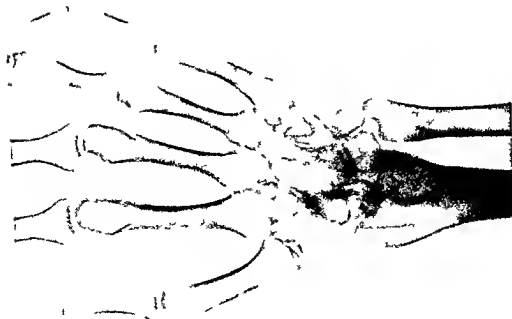


FIG 137a



FIG 137b

FIGS 137a and b L N B Rheumatoid arthritis



FIG 131. B.C. W. in image 124. Three years' history of chronic arthritis occurring in a single joint. Histologically not tuberculous

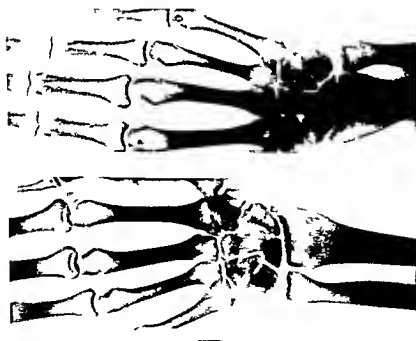


FIG 178. Bilateral Kienbock's. The appearance of disease in the right wrist followed nine months after the left

odd condition of chronic arthritis associated with innumerable tiny melon seeds (This is perhaps not always due to tuberculosis) In the few cases the author has seen and operated on a synovectomy which was merely as complete as he could manage with preservation of the joint followed by a few months immobilization has been successful

TREATMENT

Synovial disease.

Primarily conservative a close fitting plaster cast from just below the elbow to the knuckle joints holding the wrist in about 30° of dorsiflexion The elbow must be included if it is desired to immobilize the lower radio ulnar joint In cases definitely tuberculous immobilization must be kept up for at least a year after the last symptom or sign of activity has gone and until there is radiological evidence of healing (clear outlines and advanced recalcification)

In young children the outlook is promising but in older patients or when there is advanced disease of the carpal bones operative treatment is commonly necessary

Operative

(a) **Arthrodesis** in order to promote sound healing in a joint in which the active disease has been arrested This may take the form of extra articular grafting between the radius and the first line of carpal bones This operation is not truly extra articular because in the preparation of the raw bone the joint is open At this point the opportunity should be taken of erasing any diseased material

The graft used is a stout osteo periosteal graft from the tibia

(b) **Excision and arthrodesis** In this operation the first step is a synovectomy as complete as possible together with the erosion of the lower surface of the radius and the removal of any extensively diseased carpal bones If possible a raw surface of healthy bone is brought into contact with the lower end of the radius It is best to add posterior osteo periosteal grafts

(c) **Excision of all the carpal bones**, leaving a mobile false joint (? pseudarthrosis) (Fig 141) This is quite often the wisest procedure

After-treatment.

Plaster is for conservative treatment

NB In this as in all post operative plasters a vertical split is made to allow for subsequent swelling

In cases where there have been heavily infected sinuses they must be opened and drainage maintained Young patients do well healing almost always follows and if the hand has been kept in the right position (see below) good function follows But in old people the disease may be so widespread that adequate drainage is impossible Indeed one must confess that hateful



FIG 141



FIG 140b



FIG 140a

FIGS 140a and 140b. Woman age 45 Six months after cyst on lateral aspect of knee joint. The position of carpal bones which I feel as so in left side movement

as it is, amputation occasionally has to be done for extensive septic disease in the wrist and hand of an old person

In all cases where a hand is to be immobilized for a long time on account of extensive septic infection, it is vital that the thumb and fingers should be accurately opposed from the very beginning. The wrist position, the wrist in 30° or 40° of dorsiflexion, the thumb abducted and partly opposed, with the interphalangeal joint free (or, if the area of disease allows, with



FIG. 142 Position of choice for immobilization of the wrist

both its distal joints free) The other metacarpo phalangeal joints should be free to flex or, if they must be held, held in a position of at least 30° of flexion

These points are mentioned because so many of these cases are put upon straight splints with the hand flat and the metacarpo phalangeal joints fully extended, this is a bad fault since it involves prolonged, perhaps permanent, loss or diminution of function, the need for much prolongation of treatment, and a great deal of pain in the subsequent efforts to restore mobility. All this can be avoided

Indeed, when one remembers the experience of the old days, and the teachings of the early years of this century, as regards operations on the wrist for tuberculosis, and particularly wide resections without arthrodesis in comparison with those of the present day, one realizes the importance of orthopaedic immobilization and after care. In the past, various operations were tried and almost all failed, and in a great many cases the hand was eventually amputated as a result of inadequate immobilization in a bad position

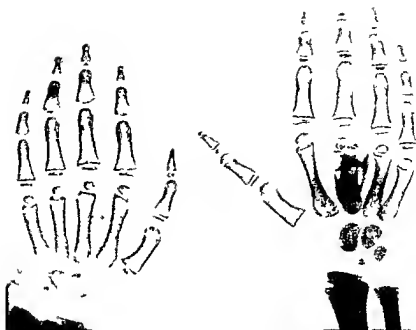


FIG 143a Child aged 4 Tuberculous dactylitis Treated by curetting of abscess and suture of skin incision

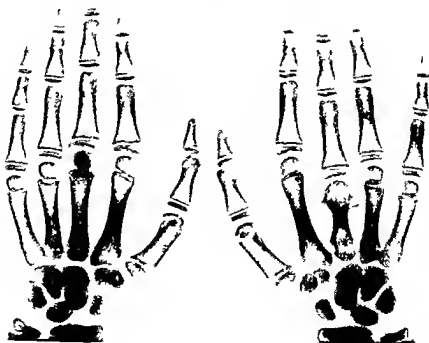


FIG 143b Same case 5 years later

CHAPTER XVI

METACARPUS AND PHALANGES

For the morbid anatomy and diagnosis see Metatarsus and Phalanges

Treatment too is similar except for the very important matter of posturization of hand and fingers (see above) and the great value of preserving every part of the hand to which function can be restored. The sacrifice of a finger

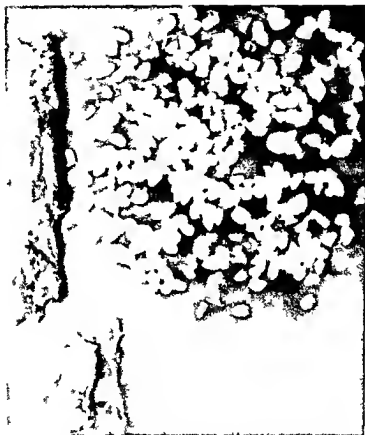


FIG. 144. Melon seeds and infiltrated tendon sheath seen over
from one finger of E. H.

or of a metacarpal is however infinitely preferable to a risk of the infection spreading into the carpus or the common tendon sheaths.

Tendon sheaths

The tendon sheaths particularly the compound ganglion tendon sheaths of the hand and wrist are liable to subacute or chronic tenosynovitis of the melon seed variety. There is as a rule an enormous distension of the sac by innumerable small seeds which arise from the synovia. The synovia

itself is thickened and a granulomatous infiltration surrounds and penetrates into the tendons

Operation is inevitable and involves a prolonged and difficult dissection. At the end of such an operation the author feels vaguely dissatisfied and on the horns of dilemma for since the elimination of the infective infiltration cannot have been microscopically complete the fingers should be immobilized long enough to satisfy the standard principles of the treatment of tuberculosis yet this is clearly incompatible with the restoration of free mobility. Fortunately however this type of synovial disease responds favourably to a relatively short period of immobilization say about six weeks. The hand is of course immobilized in the position described and illustrated on p 219

Much more rarely the tendons of one or more fingers are involved. Here again operation is inevitable and once more the dissection involved is so extensive that the preservation of the finger or fingers seems futile. At the same time it is worth attempting (Case C H)

Case E H Age 28 Male

First seen 2^o x 37 with immense swelling of the first and second fingers fluctuation and melon seed sensation

History Two years slow progressive increase in swelling. Movements of the affected fingers much limited though the limitation appears to be entirely due to the swelling and there is no pain or rigidity 5 x 37

Operation Incisions made on the radial side of the index finger and ulnar side of the middle finger prolonged into palm. Skin flaps reflected carefully avoiding the digital nerve and vessels. Flexor tendon sheaths exposed and found to be greatly thickened. On opening the sheaths a large number of small round melon seed bodies were evacuated more numerous in the index than the middle finger sheath. The thickened tendon sheaths were dissected out as completely as possible in their whole length. The operation was done under a tourniquet which was released for a period at 30 minute intervals. Skin wounds sutured.

Section shows small tubercles with infrequent giant cells with much round cell infiltration. Returned as definitely tuberculous of low grade type

19 x 37 Fingers put in plaster in semi flexion

10 11 38 Much less swollen no local heat some increase in range of movement. To leave off splint and give the fingers natural use

8 x 39 Has been in active work as chauffeur during the last four months

CHAPTER XVII

POTT'S PARAPLEGIA

PARAPLEGIA occurs in about 10 per cent of all cases of spinal caries it is much more common in the thoracic spine than elsewhere in a recently published series¹ the lesion was located in the thoracic spine in 157 out of 186 cases. Unfortunately there is a great deal of misunderstanding with regard to the treatment of this most threatening complication, and no clear modern statement has been made of the indications for operative treatment and of the conditions necessary for its safe performance. Even now opinion is commonly based upon old reviews of work carried out under extremely mixed conditions. The result has been undue conservatism and many patients have been needlessly allowed to suffer permanent paralysis with its wretched and fatal sequelae.

Two main groups can be distinguished by their onset being early or late in relation to the disease of the spinal column.

A *Early* associated with the primary activity of the spinal lesion.

B *Late* after, sometimes long after, the disease has apparently been arrested and the patient has left hospital.

This grouping has practical value for, generally speaking, the cases with early onset differ from those arising at a later stage. Group B can with advantage be divided into two subgroups on aetiology.

Group A.

Paraplegia often arises quite early in the disease, indeed, in adults, some awkwardness in walking due to incoordination and spasticity is not uncommonly the first arresting symptom, see Case C M. This is seldom so in children, both because paraplegia appears relatively late and because the caries is discovered earlier. More attention is paid to backache in children than in adults. Indeed, paraplegia in children is becoming very rare in many places on account of early diagnosis and effective treatment.

Case C M. Male, aged 19. Admitted to the Wingfield Morris Orthopaedic Hospital, 12 January 1921.

History. Kyphosis in dorsal region present for an indefinite period. Onset of loss of power in both legs commencing three weeks before admission. Patient walked up to Out Patient Department with spastic gait.

X-ray (12.1.21) Bodies of D 6, 7, and 8 largely destroyed. Abscess shadow. Voluntary power—R and L legs nil. Spasms—R and L legs + +. Sensation

¹ Butler, R. W., 'Paraplegia in Pott's Disease with special reference to the Pathology and Etiology', *British Journal of Surgery*, vol. 22, no. 88, 1935.

—light touch lost below 8th dorsal Sphincters not affected Reflexes—abdominals minus knee jerks +++ ankle jerks +++ Wassermann—negative

Despite immobilization on spinal frame the paralysis deepened and became complete, motor sensory and sphincter

28 i 21 *Laminectomy and graft* D 6 7 and 8 spines and laminae removed Dura pushed through opening at once and began to pulsate well Prominence palpable in front of cord This had clearly compressed the cord against the laminae Tibial graft fitted to bridge the gap from two spines above to two spines below Many transverse cuts to make it fit Immediate result sensation and muscular control of the lower limbs recovered the same evening but this improvement was not maintained, and in two or three weeks there was complete sensory and motor paralysis and incontinence

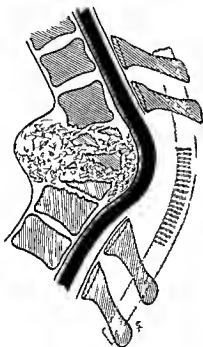


FIG 145 Case I C.V.

12 vi 21 *Enlargement downwards of laminectomy opening without damage to graft* Graft and membranes inspected The theca was found projecting backwards through the laminectomy opening and pushed against the lamina at the lower edge of this opening It was found possible to remove enough of this lamina by undercutting the graft

Fig 145 indicates the state of affairs at the end of the first decompression Fig 146 shows the compression found at the second operation owing to increased accumulation in front of the theca It was noteworthy that the graft was rounded covered with a vascular fibrous membrane and had retained its arch it appeared to form an extremely strong and fully adequate internal splint

14 vi 21 Incontinence of urine and faeces ceased

30 xu 21 Complete recovery of sensation and sphincter control partial control of voluntary power

12 xu 22 Getting up in spinal support and calipers and learning to walk

21 iii 23 Great improvement in walking

30 iv 23 Discharged

3 iii 26 Very well indeed

3 vi 37 This patient is now perfectly well and active There is no trace of paraplegia 1 ft He has been at work for more than ten years

Group B

(i) *Unsound healing Recrudescence of disease* In this group paraplegia may occur a year or even less after a patient has been allowed to get up The healing has been unsound and has given way before the pressure of body weight and strain of movement The risk of paraplegia from pressure associated with an insidious recrudescence of disease is indeed run by every patient who is allowed to get up after an inadequate period of decubitus or with inadequate protection This furnishes an argument in favour of operative posterior fusion whenever there is any doubt of the stability of the spine after the arrest of a lesion

(ii) *Great deformity* The other group is of much later and more insidious

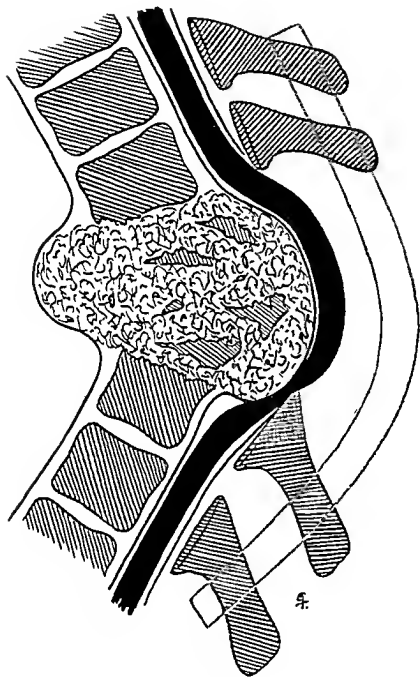


FIG. 146 Diagrammatic.

occurrence and is associated with long continued extreme angulation of the column. This group consists of adults only.

In some of these cases (B 11) the cause is comparable to that which operates in the paraplegia of scoliosis, where the symptoms seem to be due to a prolonged stretching and dragging of the cord against an irregular and angled bony bed coupled with the varying strain transferred to the cord by flexion of the head and neck above, or by the pull on it from below via the sciatic nerves and associated with changes in posture. This group is distinguished by a complete absence of any clinical signs of tuberculosis or radiological signs of compression. Furthermore, Queckenstedt's test is always negative.

THE CAUSES OF PARAPLEGIA

1 Oedema

There is considerable evidence of the existence of an early form of paraplegia due to a change in the circulation of the cord in the neighbourhood of the lesion without gross compression. This is generally associated with the early and most active stage of the disease, when there is vascular engorgement, infiltration, lymphatic obstruction, and as a rule, some mild circumferential compression. The paraplegia is 'Transient' and as quickly relieved by immobilization as is the 'Transient' arthritis of the hip.

2 Compression

From in front

- (i) By abscess, which, by tracking backwards is producing extradural compression of the cord. This condition is generally associated with radiographic evidence of a tightly distended pre and para vertebral abscess (Fig. 147).
- (ii) By a granuloma or a collection of debris (or both) developing in the extradural space behind the spinal column without radiological signs.
- (iii) By bone: (a) by pressure from a sequestrum, which has been pushed backwards by the increasing angulation.
(b) Pathological fracture dislocation.
(c) Extreme angular kyphosis.

From behind. By a granuloma or a collection of debris associated with disease of the ring rather than the column, i.e. lateral articulations, pedicles, or laminae, often with little or no visible radiographic abnormality.

THE MARCH OF SYMPTOMS AND SIGNS

The first symptoms of paraplegia are commonly stiffness and awkwardness of gait. The legs get more spastic and uncontrollable, until the patient is confined to bed. Actually this may help to arrest the progress of the paraplegia, otherwise sphincter disturbances follow and about this time alteration in sensation can be detected. Such is the usual progression because the cord is most often compressed from in front.

At first the spastic limbs lie extended but if the pressure is severe or long maintained painful flexor spasms appear, producing the full picture of paraplegia in flexion which indicates a complete loss of conductivity of the pyramidal tracts. In very exceptional cases the compression is sudden enough to cause an initial flaccid paralysis from spinal shock (Case H L.)



FIG 147 F.S. Male aged 23. Pre and para vertebral abscess.

Case H L. Male aged 21. Fig. 151.

Sudden collapse of vertebral body while patient was putting on boots causing complete flaccid paralysis below lesion.

x 23. Laminectomy within a fortnight. Laminae of D 10, 11, and 12 removed. No pulsation of cord below level of D 11. Definite flattening of cord and dura at the upper level of D 11. Cord below this seemed shrunken. After full exposure cord and dura swelled out to normal size, but pulsation appeared less in scope. There appeared to be a smooth rounded prominence in the region of D 11 that was pushing the cord forwards but no granulation tissue was found. The laminectomy opening was everywhere made smooth. A double graft cut from the L. tibia was placed bridging the opening from the 3 dorsal vertebrae above to the lumbar vertebrae below.

x 24. Nephrectomy R. (after 5 months haematuria and recurrent high temperature). Stone removed with part of ureter.



FIG 148b



FIG 148a

Figs 148a and 148b Case H B. Worn an age 123. After operat on

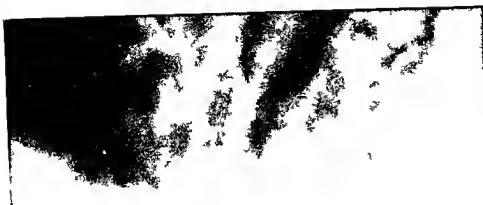


FIG 10. Male aged about 18. Extreme angular kyphosis with bone pressure very late onset of paraplegia

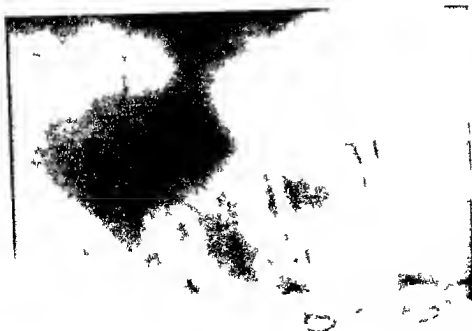


FIG 11. Male aged 26. Hypophyseal adenoma with onset of paraplegia noted within three months of an apparently normal examination. Myelographic findings show pathological dislocation

- v 24 Passed a stone X ray—no further stone visible
 xi 24 Massage and gentle movements to legs—improving Still incontinent Urine.
 occasional trace albumin
 i 25 Spinal support applied No pus in urine
 iii 25 Muscular control and sensation returning Some pyuria



FIG 151 H L Male aged 21

iv 25 *L leg* Voluntary control greatly improved Goes into spasm after a few minutes' effort Sensation slowly improving Can tell when he is being touched, but there is no tactile localization below knee Cannot distinguish between pin and finger

R leg Control not so good as *L* Cannot maintain extension of *R* knee Goes into spasm with very slight provocation Sensation similar to *L* Can distinguish hot and cold fairly well

vi 25 Control of legs improving Still completely incontinent Occasional albuminuria

vi 25 X ray shows graft intact

- vii 25 Stood for a few minutes
 viii 25 Walks with one stick and one person helping Still has albuminuria Temperature normal
 iv 26 Progress satisfactory, less ataxic Urine clear
 vi 26 Marked improvement in walking Persevering with exercises and re education
 viii 26 General condition good Discharged from W M O H
 xii 27 Graft perfect No kyphos Paresis below D 7 nerve distribution Incontinence of urine and faeces Legs spastic Knee jerks plus Plantar reflex extensor
 ii 30 Seen at his own home States that he is not entirely incontinent now Walks with a rather spastic and incoordinate gait Voluntary power fair Ankle clonus R and L Patella clonus R and L Tight spasmodic T A R and L Knee jerks plus R and L Plantar reflex extensor Abdominal reflexes present Sensation to pinprick diminished below line of anterior superior spines
 ix 36 Patient writes *My general health remains very good, but I am unable to get about very much Activity is confined to operating my Experimental Transmitting Station no other work of any kind*

Urinary sepsis and pressure sores are common and very serious complications

PROGNOSIS

Group A.

In Group A the paraplegia is directly associated with active tuberculosis, nevertheless the activity of the disease and its neurological complication are not fully interdependent for the paraplegia may yield, though the tuberculosis proves fatal, or on the other hand the tuberculosis may heal and the paraplegia remain Of what value to most of us is life with permanent paralysis to be alive and remain paralysed is doubtfully preferable to death from tuberculosis after recovery from paralysis¹ To quote Pott¹

The patient becomes unhealthy, and languishing for some time under a variety of complaints dies in an exhausted, emaciated state, or, which is still worse, drags on a miserable existence confined to a great chair, or bed totally deprived of the power of locomotion, and useless both to himself and others

This in an infant is most melancholy to see, in an adult most miserable to endure²

Actually the surgeon must accept more direct responsibility for paraplegia than for death, since he can almost always avoid permanent paralysis but cannot always promote immunity In Group A though the paralysis is often complete, if the patient is seen in good time the paralysis is curable provided that the tuberculosis can be arrested There are very rare exceptions to this rule, of which an example is described by Seddon² Other factors influencing prognosis are as follows

1. The age of the patient.

Although a recent analysis of a large number of cases shows there is no relation between the age of the patient and the prospect of the recovery of the paraplegia, it is the author's opinion that if the prospect of life, in addition to that of recovery from paraplegia, is taken into account the prognosis will be much better in the young than in the old

¹ Percival Pott (F R S) 1779

² Seddon, *British Journal of Surgery*, April 1935, vol 22, no 88, p 774

2 The duration of the paraplegia

It is safe to say that the longer the paraplegia has existed the less likelihood there is of recovery either by conservative or by operative treatment

In Seddon's¹ series 13 recovered after three months total motor paralysis 11 after six months 3 complete and 1 incomplete recovery after nine months 2 after one year 4 complete and 3 very incomplete recoveries in the second and subsequent years He says the chances of complete recovery from total motor paralysis of more than six months duration are extremely poor

On the other hand the author feels very strongly that a patient who has been completely paralysed by a compression form of Pott's paraplegia and who has for some unhappy reason been allowed to remain completely paralysed for many months ought to be given the chance of recovery however slight offered by relief from compression under conditions of uninterrupted immobilization

In late onset paraplegia Butler has drawn attention to the association in his series of a high protein figure in the cerebrospinal fluid with a good prognosis This would support the author's belief that the paraplegias which are due to extra thecal recrudescence of the disease are more susceptible to treatment and more recoverable than those associated with the intrinsic changes within the cord following long continued severe angulation of its bed

3 The nature of the paraplegia

(a) **Motor loss** The deeper the motor paralysis the less favourable the prognosis Partial paralysis is more favourable than complete paraplegia in extension which indicates an incomplete pyramidal lesion while this is far more hopeful than paraplegia in flexion which means the complete loss of pyramidal conduction But the author does not go all the way with Seddon when he says we already know that complete loss of voluntary power resulting from paraplegia in flexion or flaccid paralysis carries a hopeless prognosis Later he says in pathological dislocation and in compression by sequestrum the prognosis is almost hopeless as regards the paralysis and generally so as regards life² On the other hand the author has in his own experience found exceptions to the hopeless prognosis given both in regard to flaccid paralysis (see Case H L) and prolonged paralysis in flexion (see Case H B) It is probable that exceptions occur in regard to sequestrum pressure too The intensity and the duration of the compression must be the factors which determine whether or not the cord can recover and the intensity of compression in Pott's disease is very rarely in any way comparable to the mortal crush of a fracture dislocation

(b) **Sensory** The more complete the loss of sensation below the lesion the more unfavourable is the prognosis the motor tracts bear the brunt of the pressure except in the rare instances of pressure from behind

¹ loc cit

² Seddon however in a personal communication (1939) agreed with the author in allocating operative relief of pressure in such cases

(c) **Sphincter control.** This loss, too, indicates greater pressure, and for that reason a less favourable prognosis

It is easy to be unduly depressed by a list of unfavourable signs and symptoms, and to adopt too gloomy a view with regard to the patient who presents them. Pressure on the cord which has developed gradually is far less harmful than a sudden crush. It is true that pressure severe enough to cause loss of all motor power, sensation and sphincter control is naturally more harmful than less pressure, but so long as pressure develops gradually it is not only its degree but also the length of its duration that makes for irreparable harm. Total loss of conduction due to gradual compression does not carry a hopeless prognosis. But there is no time to lose!

4. The illness of the patient.

Apart from the above points the signs of active tuberculosis in general, of persistent activity of the local focus in spite of good general and local treatment, or the presence of a secondarily infected discharging sinus are, of course, very unfavourable features

5. The treatment.

Early diagnosis and prompt effective general and local treatment of the spinal tuberculosis make the onset and serious advance of paraplegia very rare. But if it does develop, the particular factor at work is discovered and eliminated (if necessary by operation) without delay sufficient to run the risk of permanent damage to the cord. The author believes that the prompt skilful treatment of the disease, coupled with the skilful treatment of the paraplegia, should it arise, and operative relief of the cord from pressure without undue delay will, with the rarest exceptions, eliminate the tragedy of permanent paraplegia. The most important variable factor in paraplegia is the quality of the treatment

DIAGNOSIS

The diagnosis of Pott's paraplegia in cases where the paraplegia itself brings the patient to hospital is the recognition of spinal tuberculosis as the basic cause (see p 102). In most cases the diagnosis is clear from the history, clinical examination and radiography, for as a rule the radiographs are characteristic of spinal caries, but X ray signs may be anomalous or even absent. Evidence of erosion is absent or very difficult to detect when the disease is mainly subperiosteal, or affects the posterior surface of a body, or some other part of the vertebral ring. The development of pressure on the cord from a posterior subperiosteal granuloma or abscess without radiographic signs gives rise to the so called 'spinal tumour syndrome'. The diagnosis of tuberculosis as the underlying cause then depends on other evidence, but if the paraplegia is severe with a positive Queckenstedt test and adequate localization, surgical decompression is indicated without delay, for rest in extension or hyperextension does not relieve paraplegia in the 'spinal tumour syndrome'. Sometimes

it may be difficult to decide especially in older patients, whether the underlying disease is tuberculous or malignant (see Figs 152 *a* and *b*)

Localization of the compression.

The evidence of neurological examination and radiography commonly combine to localize the compression. If a tense paravertebral abscess is shown



FIG 152*a* Woman over 60 Secondary carcinoma

coinciding with the level of the neurological lesion it is evacuated by costo transversectomy without need for further localization, so, too, when there are clear radiographic indications for laminectomy. But when the X ray evidence is less conclusive, it is always advisable to carry out Queckenstedt's test in order to prove compression, and incidentally to obtain cerebrospinal fluid for examination.

With this proof of compression and thorough neurological examination, localization is usually fairly exact but if the signs are equivocal lipiodol may come under consideration particularly as accurate localization is very desirable in tuberculosis in order to minimize the field of the laminectomy. But on the other hand one must bear in mind that opening the theca is generally undesirable in this condition, and may be strongly contraindicated, thus the

lipiodol will remain and may later give rise to root pains. There is however little fear of this if the best quality (spinal) lipiodol is used and if it is tested for colour by comparison with a tube of poppy seed before injection.

TREATMENT

Preventive

First of all immediate general and local treatment for spinal caries with special attention to full extension or hyperextension is necessary. In many places Pott's paraplegia is becoming rare due to early diagnosis and prompt effective treatment.

General

This is carried out on exactly the same lines as that described for the treatment of uncomplicated spinal caries with any necessary modifications described below.

The decision between conservative and operative treatment

Group A One can rely upon a natural recovery with good general and good local conservative treatment when the motor paralysis is not complete sensation is intact and some control of the sphincters retained particularly when there is no radiological evidence of a tight paravertebral abscess.

For example a boy of 15 comes in with a slightly spastic gait. There are radiographic signs of caries in the mid dorsal region but no obvious paravertebral abscess. This patient is put on a spinal frame in full extension with a moulded pad over the kyphosis. In such a case the paralysis might be expected to diminish progressively starting within a few weeks and if this was borne out one would be confident that the cure would be complete.

On the other hand the prognosis is different in a second type say that of a

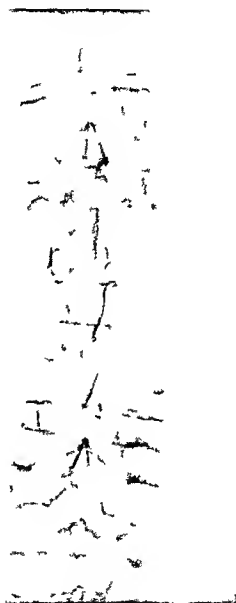


FIG 152b

woman aged 23 with a complete motor paralysis in extension and with radiographic evidence of a tight paravertebral abscess together with mutual erosion of two mid dorsal vertebrae. There is a history of advancing spasticity for the previous two months and the patient looks ill. She is immediately put on a frame or, if the kyphos is too severe, on an accurately fitting plaster bed with kyphos pad. In such a case can one rely on natural recovery within a reasonably short time? Is it not probable, on the other hand, that for a period at least the debris of destruction will accumulate and, since the paravertebral abscess is already tensely distended, will cause increasing pressure on the cord? In such a case the author feels that the prognosis without operation is dubious and that every day's delay increases the damage to the delicate structures of the cord, and makes it more likely that this damage will be partly or wholly irreparable. In such a case his practice is to carry out costotransversectomy as soon as the patient is comfortably settled on her frame and improving in general condition.

Let us take a third example from Group B of a woman of 40 with complete loss of conduction, motor, sensory, and sphincter. Her spinal tuberculosis was discovered late, she has already much local bone destruction with marked angulation and pathological dislocation, but there is no sign of a paravertebral abscess. In such a case the author would regard the prognosis without operation as poor. He would begin by immobilization on a Robert Jones' frame with a kyphos pad to provide controlled extension and, as in all these cases, with the preparation of a 'turning case', then, as soon as the patient is comfortably settled and fit for operation, would carry out laminectomy sufficiently long and wide to give good exposure in order that any steps necessary to relieve the cord from pressure may be taken, and follow this with posterior spinal grafting.

The following case shows that special circumstances may justify operation in a case when hope seems quite forlorn.

Case H B

1 in 35. A woman with three years' history of Pott's paraplegia with motor, sensory, and sphincter loss. All signs of tuberculous activity over. Paraplegia in flexion with severe flexion deformities of the hips and knees. Knee and ankle clonus. Plantar reflexes extensors. Extreme spastic rigidity.

She had been in a special surgical and tuberculous hospital for 9 months, going in with complete paraplegia and being discharged 9 months later with the paraplegia unimproved.

She was returned to the Isle of Wight and the notes say 'condition of patient unaltered complete paraplegia and incontinence'.

'Seen again by a surgeon in 1931 who reported 'gone beyond repair'.

Patient's state young married woman requiring constant skilled nursing and unable to return to husband and no hope of ever doing so.

It was explained to the patient that so far as was known there was no hope of recovery and no hope of helping her operation. This caused her the greatest distress for the reasons mentioned. She was anxious that if there was the least possibility of hope operation should be carried out, however slight the hope.

It was decided that her attitude was reasonable and that an operation, which would otherwise have been unjustifiable, was justified.

15 iii 35 Operation laminectomy Four laminae removed The theca was lying in a narrow, rather tortuous bed apparently surrounded by firm old granulation tissue which bulged backward into the wound The opening was carefully bevelled and smoothed Within a month sensation had improved

20 iv 35 Patient still has incontinence of bowel and bladder, but now is conscious of desire to go to stool and urinate which she did not have before Sensation has shown a phenomenal return being present equally over the whole body except the dorsum and soles of feet which are slightly hypersensitive to pin prick

Spasms not nearly so marked Previously patient went into spasm when touched Now has very few spasms

Reflexes not as active

Adduction spasm has become much less Patient can now adduct and abduct knees slightly herself

13 v 35 Patient can move left foot in all directions No movement in right ankle but can move toes of right foot

16 v 35 Can move hips slightly

13 vi 35 Has about 5-10° range of movement in both knees Hypersensitivity to pin prick over plantar surfaces of feet not as marked as before Reflexes all less active

5 vii 35 Hip spica applied Both legs in

23 vii 35 Plaster wedged at knees

30 vii 35 Plaster re wedged

13 viii 35 Plaster re wedged at knees

18 ix 35 Operation Open tenotomy of hip flexors left Incision made along the anterior border of the ilium extending down the thigh All tight structures including the iliopectas were cut Thigh then extended as far as possible Patient has a fixed lumbar lordosis Put in plaster with left leg extended as far as possible and right flexed on the pelvis

19 i 36 Plaster to be bivalved

30 i 36 To go into the warm swimming bath for exercises

28 ii 36 Operation Under evipan and G and O₂ right knee manipulated into extension Guarding plaster then applied from groin to ankle with knee almost straight

19 iii 36 Plaster wedged in further extension

31 iii 36 To come out of plaster

6 v 36 Walking with caliper

29 v 36 Walking very well

24 vi 36 Discharged from Wingfield Morris Orthopaedic Hospital

15 ii 37 Operation Elongation of Tendo Achilles R and L R T A lengthened by open operation $\frac{1}{2}$ inch L T A lengthened by $\frac{1}{2}$ inch Operation on R big toe Arthrodesis of interphalangeal joint and lengthening of E P H Plaster applied to both feet

8 ix 37 Re admitted to W M O H for review No spasm of R leg muscles No sphincter disturbance Knee jerks R and L = ++ No ankle clonus Plantar reflexes extensor Discrimination of fine touch present on trunks and both legs Hypersensitive on soles of both feet Heat sensation present on both legs but rather unimproved on lateral aspect of R thigh

Needless to say, the patient is delighted to be restored to reasonable activity and to life at home with her husband

Group B. Here we have to deal with two quite distinct groups of cases

(i) Those due to compression

(ii) Those due to long continued deformity without compression

Here an analysis of the cause is obviously the first step, exactly on the lines adopted for Group A, followed by treatment on the same lines

In both subgroups we have to deal with a number of very severe deformities. In such cases the radiological work is difficult but of most critical importance. Stereoscopic lateral radiographs of the highest quality are necessary, and we ask of them a clear view of the boundaries of the spinal canal, both in order that we may see whether there is evidence of recrudescence of disease and so that we may visualize the spinal cord as it lies against the anterior wall of the canal, at the apex of the kyphos formed by what is left of the bodies with, perhaps, a ridge of bone or prominent sequestrum (Figs 153 and 154). In those cases in which there is no severe deformity, no ridge or sequestrum to be seen in the lateral view, we examine the A P stereos for evidence of a tense abscess

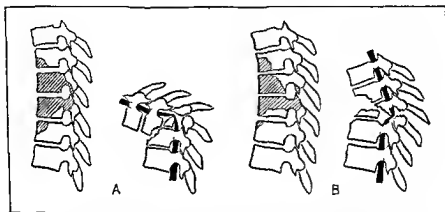


FIG 153 Diagrams showing two ways in which punching of the cord may result from pathological dislocation from Pott's disease in the thoracic region. The shaded areas are those in which bone is destroyed.

- A The upper segment of the spine has slipped downwards and forwards.
B The segment has slipped downwards and backwards.

Lumbar puncture, the examination of the cerebrospinal fluid, and Queckenstedt's test give further information. Here again, as in Group A, the surgeon must discover pressure and take steps for its relief, by conservative means if the clinical picture allows the time without risk or harm to the cord, but by operative means without delay when delay would involve risk of permanent neurological damage. *For the reasons mentioned the author does not agree with Butler in saying*

"The only real test of ability to recover is to put the patient under treatment by fixation in recumbency, as for active (persistent or recurrent) tuberculosis of the spine and await results, whether such disease is clinically present or not. With the passage of time Type III paraplegia is then found to fall into one or other of two subdivisions:

Type IIIa Late onset paraplegia recovering on conservative treatment as for active tuberculosis of the spine.

Type IIIb Late onset paraplegia not so recovering."

Butler reports 96 cases, of which 58 recovered, 38 did not. The author is not in agreement with this policy of uncritical expectancy. He recommends

an early analysis of each case in order to discern as clearly as possible the cause of the paralysis, followed by a careful assessment of the value of operation, whether decompression or synostosis. Synostosis diminishes the accumulation of debris by eliminating the grinding movement of respiration, and in so doing favours the arrest of the disease.

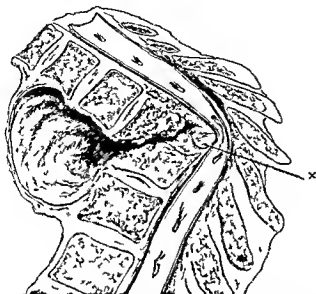


FIG 104 Drawing showing pathological dislocation of the thoracic spine in Pott's disease with pinching of the cord. The upper segment of the spine has fallen downward and forward over the lower so that the bone compressing the cord is the persisting postero-inferior corner of a vertebral body which has remained in position forming the apex of the lower segment.

In regard to the 'B' group Butler has drawn attention to the association in his series of a high protein figure in the lumbar cerebrospinal fluid with good prognosis (Table 26). This would support the author's belief that the paraplegics due to recrudescence of disease are more susceptible of treatment, and more recoverable than those associated with the late mechanical effects of severe angulation.

Summary of clinical picture.

Partial motor paralysis without any sensory loss or sphincter derangement is favourable and can safely be watched for a time, which will be relatively brief if there is direct evidence of compression. In complete motor paralysis the less the duration of paralysis, the less is the likelihood of permanent damage. The deeper the motor paralysis the less favourable the prognosis. Sensory loss, or loss of sphincter control, added to complete motor paralysis suggests that the pyramidal tracts, which bear the brunt of

anterior pressure, have been compressed more than is sufficient to stop their conduction

Apart from these neurological points, signs of active tuberculosis in general, infection of the urinary system, deep or septic pressure sores, pregnancy, illness and old age are, of course, unfavourable features

TABLE 26

Protein of the Cerebrospinal Fluid in Late Onset Paraplegia in Relation to End results of Treatment

Serial number of patient	Persistence of paraplegia prior to estimation	Protein in cerebrospinal fluid*	Result of further conservative treatment of the paraplegia as for active tuberculous disease of the spine	
	Months	G per 100 c c		
(S) 58	4	0.9	Recovered	
(B) W N	4	0.4	Recovered	
(B) D S	1	0.3	Recovered	
(S) 63	1	0.24	Recovered	
(B) E C	3	0.15	Recovered	
(B) J B	12	0.1	Recovered	
(S) 99	10	0.1		No recovery
(S) 22	2	0.08	Recovered	
(B) J D	10	0.06		No recovery
(B) E B	6	0.05		No recovery
(S) 97	2	0.03		No recovery
(S) 32	24	0.015		No recovery

* Normal 0.01-0.03

The author agrees with Seddon when he says that the early case which does not recover is usually a recoverable case gone wrong. But in Pott's paraplegia the lack of recovery is *very rarely* due to some irreparable vascular or skeletal accident and *we shall allow recoverable cases to 'go wrong' if we acknowledge any necessary association between persistent activity and persistent paraplegia*. Seddon explains that paralysis becomes permanent because *the disease persists for so long before final healing that the damage to the cord, reparable at first, ultimately becomes permanent*. The author would go a great deal further and say, with directional intent, that in such cases activity has persisted and pressure on the cord has been allowed to coexist for longer than its delicate structure can tolerate. Seddon's words seem to the author to carry an implication that pressure cannot, or should not, be relieved during the activity of tuberculosis of the spine. It is true that operation is contra-indicated, laminectomy most particularly, during the activity of disease in clinics where operation involves interruption of the accuracy or continuity of immobilization. But modern orthopaedic technique has eliminated this very serious drawback.

We should never forget the long lag between the cessation of activity and the relief or even diminution of pressure. It is no longer excusable to allow continued compression of the cord when the damage is each week becoming more irreparable, to allow further pressure to develop, perhaps to watch

progressive exhaustion from painful spasms and to let the urinary system become infected. Decompression may now be indicated even during the active stage of the disease, for the continuity of immobilization has swung the balance in favour of operation, and one can aim at earlier relief of the cord without fear of aggravating the local tuberculosis.

The nursing of a paraplegic patient.

First comes the need for complete immobilization, and, in order to ensure this, for a much more stringent yet protective form of splintage than suffices for uncomplicated spinal caries. In practice this may involve the complete enclosure of the lower limbs in plaster, for anything short of this may fail to cut out the flexor spasms. This advice is given with full knowledge that it used to be taught, and perhaps still is, that to enclose insensitive limbs in plaster was thoroughly wrong on account of the liability to the development of pressure sores, perforating because painless. The relief given from the distress and weariness of flexor spasms is very great, and the method is safe with two provisos regarding the plaster technique and the subsequent watchful care. The former is what may be described as the 'Shropshire technique', for it was worked out at Baschurch by Miss Hunt. The patient's lower limbs are first firmly and very evenly bandaged over a thick wrapping of cotton wool, then over this is placed a further layer of wool and finally the plaster of Paris is most evenly applied and carefully moulded. This is the first point—the stringent yet protective, immobilization. The second point concerns a careful watch upon the patient. All spasms should disappear in 24 or 48 hours as a result of the immobilization together with the complete elimination of any sensory stimuli from the skin. Any continuation of spasms means either that the immobilization is incomplete or that there is some point of pressure sufficient to excite reflex spasms, thus calls for the *immediate* removal of the plaster in order to find and eliminate the point of pressure for it will otherwise quickly bring about a sore.

After a successful application, the spasms are lost, the patient is at rest, comfortable by day and sleeping well at night, but a most careful watch must still be kept up. The nursing staff must understand that the warning symptoms of a sore will be represented by a brief reappearance of spasms, or even just a little restlessness at night, and perhaps only for one night! It is, indeed, essential to recognize that the warning is of short duration. The reflex spasms result from irritation of the sensory nerve endings in the skin, and this occurs only during the few hours when the pressure is enough to redden and irritate the skin, but not to deaden and perforate it. The reflex spasms are remitted by this irritating pressure on the skin, but, if the pressure continues, the irritation soon ceases because the sensory end organs are cut out. Therefore, unless immediate action is taken and the whole plaster removed on what to the uninitiated would appear a negligible symptom, the skin is penetrated and a deep pressure sore develops.

The success of a hospital in preventing the development of pressure sores in

these difficult crises, and, indeed in all the many cases on plaster beds or on frames, depends on the alertness of the probationer nurse to observe, and to record with emphasis, a hint which, unless so emphasized, appears trifling and may fail to arrest attention. For the smallest change from rest to restlessness may be the only warning of what will quickly and silently become a deep and septic sore. It is for the nurse first to notice a return of spasms or a little restlessness, then to enter the matter in the night report and in some way to draw attention to the significance of her observation.

The bladder.

Interference with bladder function always involves a decision as to whether the bladder should be drained suprapubically, by tied in catheter, or by repeated catheterization. The bladder receives sympathetic supply from Lumbar 1 and 2 cord segments. This relaxes the detrusor and closes the sphincter. The parasympathetic supply is from Sacral 2 and 3. This contracts the detrusor and opens the sphincter, therefore if the lesion of the cord is above cord segment Lumbar 1 it is reasonable to expect the development, in the course of a few weeks of a cord reflex capable of emptying the bladder periodically, i.e. an 'automatic bladder'. If, on the other hand the sacral segment of the cord has been crushed at the level of the 1st lumbar vertebra the parasympathetic innervation is lost and automatic bladder function cannot develop because the sympathetic is unopposed. In these cases early suprapubic drainage should be instituted and the bladder irrigated from the urethra and out through the suprapubic tube. Prolonged use of a tied up urethral catheter has drawbacks in that it often sets up urethritis with ascending complications. Regular periodic catheterization with all aseptic precautions, including handling the catheter with dissecting forceps only is safe in these cases even for a prolonged period.

Operative

It need hardly be repeated that the basis of treatment of all cases of Pott's paraplegia is immobilization and general treatment for tuberculosis, that in some this is the only treatment that will be required, but that in others recovery from paralysis can only be attained by operation. The field for operation is wider and its benefit greater now that the indications for one or other method of decompression are recognized and the chosen operation performed without risk of straining the diseased spine or impairing its stability. There is a tremendously strong argument for early spinal decompression in selected cases if it can be accomplished with reasonable safety, as indeed it can. In what percentage of recoverable paraplegias the compression factor is gross it is impossible to state. Even when it is severe, however, it would seem likely that its relief gives the best prospect of restoration of the function of the cord and a very good prospect provided that the compression has not been too long maintained. The author's attitude, therefore, is to look very critic

ally upon all cases of paraplegia, with clear ideas as to the indication for operation

When the patient has been accurately and comfortably immobilized on a spinal frame or plaster bed, and the turning case made ready, the points for and against operation must be considered. If the patient is reasonably fit and well, one is free to operate soon. On the other hand, if the patient is ill a preliminary period of rest and general treatment is very desirable. But even so one may be driven to a compromise between premature operation from the point of view of the patient, and delay which may prejudice the recovery of the cord. In such cases the threat to the viability of the cord and the dangers of the complications of severe paraplegia must be balanced against the poor or incomplete reaction of the patient.

The next consideration concerns the relationship between the onset and duration of the paralysis and the period and efficacy of the immobilization. One must clearly not operate on a patient whose paraplegia is relatively mild, who has not been adequately immobilized, and in whom there is no tense paravertebral abscess. On the other hand, the author would advocate operation in a case where the paraplegia was complete and a tense paravertebral abscess was present, whether there had or had not been adequate immobilization. Between these two types there is a great variety of clinical pictures, and the decision will often call for much thought and very careful study of first-class stereoscopic radiographs.

In one case the surgeon may decide to postpone operation on account of what may be termed a non reactive condition, in another he may feel that the patient is in for a long period of smouldering disease, and that to wait for a natural improvement would be to allow the cord to suffer irrecoverable damage. The author feels that on the whole it is better to operate on a certain number of cases that would perhaps recover without operation than to run serious risk of permanent irreparable damage to the cord through hesitation and delay.

In the absence of radiological evidence of pressure the author would most carefully watch progress and, generally, arrive at his decision during the first month, occasionally the decision might be postponed for a second or even a third month following the onset of paraplegia. To wait until six months have passed is, to his mind, disastrously wrong! For the delay may allow the initial damage to become irreparable, a disaster avoidable by reasonably early radical relief.

Paraplegia becomes permanent and irreparable because the pressure on the cord has increased with the advance of the disease, and then remained for a long time undiminished. For some time after general vitality has been restored the tissues in the infected area are still giving ground! *There is a lag in the arrest of erosion, and even after this another lag in the subsequent diminution of pressure.*

The author agrees with Butler in believing that many irrecoverable paraplegias are established because disease persists and toxic, vascular, or mechanical effects upon the cord become profound and irreparable.

Indications for operation.

1 *From the neurological point of view* paraplegia

- (a) arising in a case of spinal caries which is being efficiently treated, or
- (b) increasing or unimproved in spite of efficient treatment, or
- (c) already severe

2 *From the radiological standpoint* paraplegia associated with X ray evidence (or suggestion) of compression

- (a) by a tense paravertebral abscess and
- (b) by a bony angle or ridge or sequestrum or by posterior disease

In some patients the recognition of posterior osseous disease invisible in radiographs will depend on the recognition, clinically, that the sensory tracts are the most severely affected

Finally, there are the few patients who have been completely paralysed by Pott's paraplegia and who have for some unhappy reason, been allowed to remain completely paralysed for many months. The author feels strongly that they ought to be given the chance of recovery, however slight offered by a very careful and adequate laminectomy under conditions of uninterrupted immobilization. The prognosis may be gloomy and the hope forlorn, but at the worst the patient will have the satisfaction of knowing that no stone has been left unturned. Case H B is an outstanding example of the value of giving weight to the patient's personal point of view.

The conservative treatment of Pott's paraplegia demands a staff skilled in the orthopaedic splintage and nursing of the primary disease and in neurological investigation.

The surgery of paraplegia demands a skill and experience in spinal surgery with a highly trained team and a well equipped theatre served by a staff whose aseptic technique is beyond question. Indeed, the decision between the continuance of conservative treatment or operation demands much experience, knowledge and wisdom and the choice can only and rightly be free if the surgeon has full and true confidence in his operative skill and judgement, in his team, and his equipment.

Operations

1 **Aspiration of a paravertebral abscess** This has been recommended (Calot), but the author has never employed the method, and feels that it is far better to do a costotransversectomy, partly on account of the difficulties and dangers of the aspiration, but mainly because of his experience in a considerable number of costotransversectomies that the abscess contents are not of the kind which flow through a cannula.

2. **Costotransversectomy.** This is the operation most often indicated and most likely to be helpful. Its indication is a paravertebral abscess which appears tense from its spherical or fusiform shape. Asymmetry does not mean lack of pressure. One side will often appear the larger, and naturally this is an indication for carrying out the costotransversectomy on the side of the large bulge.

3. Laminectomy. For decompression in the absence of radiological evidence of a paravertebral abscess

4. Posterior spinal fusion (see spinal caries) Indicated in Pott's paraplegia *after the relief of pressure*

- (a) To restore stability in the spine and to provide strong permanent immobilization of the whole of the diseased segment
- (b) Especially in mid and low dorsal disease in order to stop the grinding effect of respiration with the result of daily addition to the debris of the abscess

Now and then perhaps laminectomy may be combined with a grafting operation, but only in cases where the general condition of the patient warrants the dual procedure. Otherwise grafting is carried out at a subsequent session. In certain cases of Pott's disease, e.g. following the recovery of paraplegia under general treatment, where the necessity for a subsequent laminectomy may arise the author carries out a unilateral (right) posterior spinal fusion, for this provides stability without interfering with subsequent access to the spinal cord by hemi laminectomy if necessary.

Operative technique

Maintenance of uninterrupted immobilization. For more than twenty years the author has employed a technique of splintage, in which, by the use of a turning case (see p. 128), *the spine is fully protected from any movement before, during, and after the operation.* The patient is anaesthetized on his frame, or, in the cases of sharp angular kyphos, on his plaster bed, his turning case is then put on, strapped into place, and the patient turned (Figs 81 a and b). The anaesthetist arranges the flannel bandages between the anaesthetic bars so as to support the patient's forehead. When the turning case is first laid in place, but before the patient is turned, it is very important for the anaesthetist to make sure that the edge of the turning-case cannot press on the patient's neck or axilla.

Warmth. In this operation, as in others in which a good deal of the body is covered only with sterile towels, the patient is kept warm by means of thickly padded sterile towels, which have been pre-heated.

Costotransversectomy.

The side with the greater abscess shadow is chosen. An incision 3 inches long is made on the line of the rib with its apical articulation at the level of the greatest breadth of the shadow. The centre of the incision is at the outer edge of the erector spinae. The muscles are split and retracted and the dissection is carried to, and through, the periosteum along the middle of the back of the rib. The periosteum is then very carefully and gently raised off the posterior surface, the upper and lower edges, and finally off the anterior surface of the rib. At this point it is wise to insert a long gauze swab between the rib and the periosteum. The rib is then divided about 2 inches from the tip of the transverse process. The value of the gauze swab is now apparent as it

prevents the sharp, often needle like projections on the cut rib ends from penetrating the pleura. At this point, therefore, it is well to bevel off the end of the peripheral portion of the rib smoothly and carefully. The inner segment is now grasped by lion forceps, and the periosteum and soft tissues separated from it by a blunt dissector, the final separation may require a knife, on account of its ligamentous attachments, or the carefully controlled use of a $\frac{1}{2}$ inch gouge. It is not always necessary to divide the transverse process. The abscess can now be opened by blunt dissection which should be kept close to the vertebral body. The opening should be wide enough to enable adequate exploration of the cavity, and the removal of all debris and any sequestra.

Ligation or division of the neurovascular bundle has never been found necessary by the author. After a thorough evacuation the author sometimes closes the wound completely, and in others, particularly if the pressure has been severe, he leaves a rubber drain or a vaseline gauze wick in for twenty-four or forty eight hours to avoid any possible secondary pressure. After treatment the skin is painted with the special paint (p. 25) and, if a sinus forms, the aseptic and antiseptic technique is carried out on the scrupulous lines there described.

Laminectomy and graft operation combined.

The exact identification of the spines to be attacked will have been assured by previous localizing lateral radiographs. The incision is slightly to the left side so as to keep the scar away from the spinous processes, and to allow of the motor saw being used unhampered by retractors on the surgeon's side. The skin and subcutaneous tissue are lifted from the deep fascia and reflected away from the surgeon beyond the line of spinous processes, and the skin edges are then closely and smoothly covered with thin green towels.

An incision is next made on to the apex of each spinous process and carried, by a dip of the point of the knife, through the interspinous ligaments over an area covering generally the three spinous processes of the laminectomy area, with in addition two above and two below. Since the line of processes is often disordered by caries, and since it is best to make the incision run exactly over the apex of each process it is helpful to define each process as the incision reaches it by gripping it between the points of a pair of toothed dissecting forceps held in the left hand. The motor saw is then taken, and two incisions are made into each spinous process forwards and slightly outwards, to right and to left. These saw cuts are clearly shown in Fig. 155a. They start in the knife cut and separate a thick flake of bone from the spinous process on each side. When each process has been dealt with in this way the saw is laid aside and a chisel the same width as the laminae, is used to complete the separation of the lateral flakes of bone from the central part of each spinous process, and then to carry these flakes outwards, the chisel travelling subperiosteally across the laminae. The author uses a broad chisel so that it cannot easily slip between the laminae, and so sharp that it can be used gently without disturbing the diseased spine. Each time the chisel travels outwards the space

between it and the spinous process is packed with gauze, so that by the time the upper end is reached there is a thick packing all the way up that side. The other side is then treated in the same way (Fig 155b). The laminae are only *fully* exposed where they are to be removed. In the case of the two spines above and below, the displacement of the flake of bone and periosteum does not go far beyond the base of the spinous process.

The central two or three spinous processes are then removed, preferably by giant nibbling forceps, and in this step and all others the bone is cut clean by power without suspicion of wrench or leverage which might disturb the area of disease. By further gradual nibbling the two or three laminae are removed



FIG 155a



FIG 155b

FIG 155a Shewing motor saw cuts into a spinous process

FIG 155b State of affairs after reflection of osteoperiosteal flaps in the area of the laminectomy

cleanly and fairly widely, but the preservation of the stability given by the lateral articulations is most desirable. It is all to the good if their exposure can be made to bring about their fusion.

Further procedure will depend upon the cause of pressure as previously discovered by X-rays or found at operation. In Pott's paraplegia the source of pressure is extrathecal and it is ordinarily useless and, in the presence of infected pus or debris, dangerous to open the theca.

It is essential to make the laminectomy opening wide and long enough to relieve all the pressure present or at all likely to occur. Case CM is an instance of a laminectomy opening which was not long enough, though now the author recognizes that costotransversectomy would have cured the paraplegia as quickly, more certainly, and more safely than laminectomy.¹ But in this instance, the pressure was great and had been increasing rapidly, and it is therefore likely that either a temporary tuberculous sinus would have formed, or else the costotransversectomy would have had to be repeated.

The author does not think he has ever had to remove more than three, or perhaps four, laminae for Pott's paraplegia. He does not open the dura, but 'seeks' gently round it to identify the source of pressure and deal with it. He sometimes evacuates a mass of caseous or carious debris from the side or the front of the theca with a small spoon.

Next comes the graft. The length and shape of the grafts required are recorded by bending a probe and two 'Albee' grafts about $\frac{3}{8}$ inch wide are cut from the tibia. If straight grafts will fit they are put in with the periosteal surface deep—that is with the smooth limiting membrane turned towards the theca. If the spine is straight or only moderately kyphotic, this gives plenty of clearance at the site of the lesion, because the grafts are carried fairly high



FIG 156

FIG 156 Showing grafts bridging defect left by laminectomy with their lateral osteogenetic hosts

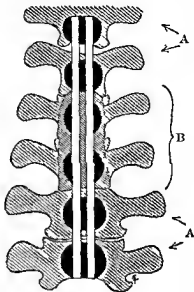


FIG 157

FIG 157 Diagrammatic coronal section of spinous processes and graft with vertebrae and area of laminectomy indicated. A Grafts well supported on spines. B Area of laminectomy

up on the spinous processes above and below. If on the other hand, there is much angular curvature, one of two methods must be used.

(a) *Shaped grafts* to fit the angulation. This means using the broadest part of the tibia and not sparing the crest.

(b) *Flexible grafts* (when a graft of sufficient length and angulation is unobtainable) prepared either by the earlier method of multiple transverse cuts about $\frac{1}{16}$ inch apart on the medullary side of an Albee graft (and for this a very fast running saw is advisable), or by a technique in which one makes a number of parallel longitudinal cuts into the tibia $\frac{1}{16}$ inch apart after a transverse cut beyond each end five or six thin and fairly flexible Albee grafts can be lifted from the tibia. Three of these are used on each side like laminated springs flexed to fit the angulation and firmly held to the spinous processes above and below by suturing. The author prefers to use a number of completely separate leaves.

When the grafts are firmly in place, and one has made sure that there is plenty of space between their deep surface and the theca, the edges of the supraspinous ligament are sewn together over the grafts (Fig 156), the lateral flakes of bone from each spinous process are thus brought into contact

with the grafts. Just previous to this, if there are one or more prominent spinous processes, they are nipped across with bone cutting forceps and bent under the suture line. This procedure makes for comfort and safeguards the skin from pressure. The operation is completed by suture of the skin of the back and the leg. Dressings and carefully graded layers of wool are then applied, the frame or plaster bed is laid in position, the straps are pulled up, and the patient is 're turned'.

After-treatment.

The patient remains on his frame or plaster bed for three or four months. He is turned, whenever necessary, by the method described (the routine in all cases of spinal caries) and each time the utmost care must be devoted to the exact adjustment and soft smooth padding of spinal frame or plaster bed.

Finally the author would emphasize three things:

1. He believes that if laminectomy is to be employed for Pott's paraplegia it should be supplemented by grafting at the same or a subsequent session.
2. Good technique in such grafting is vital for the grafts have to bridge the laminectomy opening without absorption, and because the strain on grafts in Pott's disease is often great. Therefore the grafts must be strong and be given as much contact with bone as possible, or there will be risk of their absorption or fracture. It is for this purpose that the author separates from each spinous process lateral flakes of bone with their periosteum intact. At the end of the operation these lie with their raw surfaces in contact with the grafts providing an almost continuous series of ossific nodes.
3. The continuous immobilization of the whole spine before, during, and after operation.

THE END-RESULTS AND THEIR LESSON

The disastrous results of operation in Pott's paraplegia without uninterrupted and accurate immobilization have brought about a conservative trend of opinion which was thoroughly justified in the past, but is no longer justified. The result of this conservatism has been that many patients recover from tuberculosis, but not from paraplegia, a larger number die paralysed, their death due more to the paraplegia than to the tuberculosis. In some of the cases in Group A, there is delayed arrest of the disease, it is, indeed, a universal experience in regard to tuberculosis in all parts of the body that a local focus may show persistent activity and increasing destruction of bone for some months after the institution of good general and local treatment. Far more unfavourable are those few patients who fail altogether to respond to treatment, they go downhill until they die. And there are cases in which paraplegia adds to the severity of the illness with painful oft repeated flexor spasms making rest impossible, and pressure sores adding septic absorption to the general illness. Butler gives the mortality of Group A as something like 30 per cent. in his personal experience, and says of

this fraction that about one third die from general spread of tuberculosis. In some of his cases the tuberculosis was complicated by septic absorption from sores and the two diseases combined to kill the patient.

Early expert treatment can minimize this loss.

Paraplegia may persist solely because *operative relief of the cord from pressure is given too late or not at all*.

The group of patients who respond slowly and in whom for months the pressure on the cord may be increasing rather than diminishing presents to the author a very strong argument in favour of relatively early relief of the cord from pressure (generally by costotransversectomy). For in such cases the compression is generally due to the gradual accumulation under tension of the products of chronic inflammation and erosion. Relief from this compression can come in two ways quickly by operation or very, very slowly and after long delay as a result of first the arrest of inflammation and erosion and then the slow inspissation of the abscess. When first class surgical skill backed by orthopaedic technique and equipment are available there should be no further hesitation. But the combination is essential. Operation however skilful without associated splintage based upon experience of spinal disease and its immobilization is futile and the dangers associated with unskilful operation may well be greater than those of leaving the spinal cord compressed *sine die*. In a word the treatment of Pott's paraplegia demands first class orthopaedic surgery.

The end results of operations for bone and joint tuberculosis done not as an incident in a long programme of conservative treatment but without regard to immobilization and after care are bad and of all such operations laminectomy for paraplegia is the most disastrous. The stability of the spine at the site of the lesion is precarious and anaesthesia abolishes the protection of the voluntary muscles thus there is danger of crushing the diseased bone or of subluxation. These dangers are present during operation, be it costotransversectomy or laminectomy. Furthermore after laminectomy the stability of the spine is even further reduced. Only continuous expert immobilization can eliminate these risks. Seddon has done great service in emphasizing the value of conservative measures in paraplegia. In collecting his cases he cast his net wide and was very deeply shocked by the results of laminectomy done for Pott's paraplegia with interruption of immobilization or worse without immobilization. His references to surgical measures are therefore coloured by his disgust at the results of indiscriminate operating but he disparages operations unduly when he might more helpfully have distinguished good surgery from bad. It is indeed true that laminectomy as an isolated procedure for Pott's paraplegia cannot be too severely condemned. *Operative decompression of the cord by costotransversectomy and the evacuation of a tense paravertebral abscess or less often by laminectomy can be a procedure of the utmost value provided that the operation is carried out in association with uninterrupted and adequate immobilization of the spine before during and for months after the operation.*

APPENDIX

THE ROBERT JONES FRAMES

THESE are of two types—for the spine and the hip—but the main principles of construction are the same.

In each case the frame, as shown in the diagram, see Fig 158 consists of two vertical bars joined by four transverse bars. These bars are made of 'black iron' in three sizes— $1\frac{1}{2} \times \frac{3}{4}$ inch, $1 \times \frac{1}{2}$ inch, and $\frac{3}{4} \times \frac{1}{2}$ inch. The weight of material used varies in proportion to the size of the frame: the bars must be sufficiently rigid to bear the weight of the patient without sagging when the frame is supported on blocks.

The object of the loin bar (an Oxford addition between the nipple and pelvic bars) is to improve the fit of the saddle in this region: the transverse nipple, loin, and pelvic bars are made of $1 \times \frac{1}{2}$ inch 'black iron' or 'mild steel' ($\frac{3}{4} \times \frac{1}{2}$ inch in very small frames) and riveted to the main bars. The distance between the nipple and pelvic bars varies with the height of the patient.

The thigh and ankle bars are also made from 'black iron' or 'mild steel' ($\frac{3}{4} \times \frac{1}{2}$ inch or $\frac{1}{2} \times \frac{1}{2}$ inch) and to these are attached the 'knock knee' and extension bar which is made from $\frac{3}{4}$ inch round iron.

The nipple and pelvic bars are hinged to open outwards and backwards, being ordinarily held in place by a $\frac{1}{4}$ inch wing nut. This hinge is another Oxford innovation to eliminate the necessity for the frequent wringing of these bars, and the periodic breakage that results. The removal of the wing nut allows the bars to fall back. The hinges are 1 inch steel 'back flaps'.

The pelvic bar has a stud just below the hinge, and another in front, to these the groin straps are fixed. The nipple bar has an expanded perforated end through which the shoulder straps are double passed before being tied.

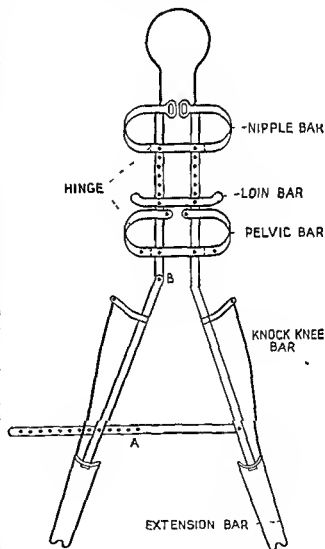


FIG 158

A head piece may be added to the frame, made of material similar to the rest of the main bars, it is fixed to the frame by $\frac{1}{2}$ inch bolts passed through one of the drill holes shown in each vertical bar between the nipple and loin bars. A sunken head piece lies parallel with the top of the frame, but, if hyperextension of the neck is not required, the bars of the head piece are bent to bring it up to the level of the saddle. No padding is needed in the head piece, for the leather is so fitted to the head piece as to form a cup shaped depression.

In the spinal frame the main bars are all fixed. In the single (or double) abduction frames one or both main bars are jointed opposite one hip (or both), and a bolt, with wing nut, passes through one of a series of holes in the transverse distance piece.

The saddle is covered in front with basil leather, which presents a smooth surface to the skin and with canvas on the under side. It is tightly and evenly packed with horse hair or flock.

HOW TO MAKE A PLASTER BED AND A TURNING-CASE

Materials

- 1 *Plaster of Paris*. This can be of the relatively inexpensive quality known as 'Coarse'.
- 2 *Fabrics*
 - (a) Brown cotton wool to protect the spine while the plaster bed is being made
 - (b) White 'house flannel', on which the plaster is moulded
 - (c) A coarse Hessian known as 'Scrim', cut into suitable strips for easy handling say a yard long by 6 or 8 inches wide for the lower limbs, and shorter wider strips for the trunk
 - (d) Gamgee tissue for the final lining of the plaster bed
- 3 *Reinforcement*
Malleable iron bars $\frac{1}{2} \times \frac{1}{2}$ inch

Plaster bed

The plaster of Paris is mixed in a large bowl into a fairly thick cream by stirring about 3½ lb into 1 quart of warm water. A sufficient number of strips of scrim have been prepared to allow for at least six layers.

The patient lies prone on a table. If the head is to be included (as is necessary in mid or high dorsal and cervical disease) it is supported by pillows and sandbags under the face and forehead till the required degree of extension or hyperextension of the neck is obtained. The legs are suitably abducted and the feet lie over the end of the table approximately at a right angle with the legs. Soft brown wool is placed along the spine and the whole dorsal surface of the patient is covered with a piece of house flannel. Enough of this material should be allowed to cover the trunk and lower limbs completely and allow a little overlap to turn back at the edges of the plaster bed in the mid line of the flanks and lateral aspects of the lower limbs.

The strips of scrim are now in turn immersed in the plaster cream and then applied to the house flannel covering the patient. Each strip should be very lightly squeezed before application, as excess of plaster tends to make the bed brittle. Each layer is well rubbed into the preceding one with the hands and the bed is moulded carefully to the patient's body. The edges of the bed overlap the midline of the flanks and lower limbs slightly and are turned back, covered with the flannel, so as to thicken these edges somewhat. When the bed is sufficiently strong the plaster is allowed to set sufficiently to enable it to be removed from the patient without giving way. The house flannel forms an integral part of the bed and comes away with it, the brown wool being left behind.

The bed is then trimmed with a sharp knife in the fork and round the axillae.

A metal bar is bent at each end to fit the back of each leg piece and is fixed across

between the leg portions below the knee level by means of ordinary plaster bandages with which the whole bar is covered. This imparts stability and facilitates handling.

When thoroughly dry the bed is lined with gamgee tissue cut to the required shape, and is then ready for use.

Turning-case.

The same materials are used for the turning case, and the details of construction are exactly similar, except that, of course, the patient lies on his back on his frame or on his plaster bed and his feet are not included in the case, which stops short just above the ankles.

When the case is to be used during an operation for spinal fusion, two 'horns' of thin metal, wrapped in plaster bandages are added to it. These project in a cephalic direction from each side of the neck bay, which must be cut well back so that, when the patient is lying unconscious on the turning case, there shall be no risk of compression of the throat. A flannel bandage is passed round the anaesthetic horns at the required level to support the patient's forehead during the operation.

THE GARSHALTON FRAME¹

(Devised by W. T. GORDON PUGH, M.D. (Lond.), F.R.C.S. (Eng.))

The spinal frame.

The spinal frame is made of gaspipe and is generally eight or ten inches longer than the patient, it has a flat transverse iron bar opposite the shoulders and a smooth wooden one just above the knees. Under the head and trunk it is slightly narrower than the distance between the iliac crests, but from the lower part of the thighs is cranked out an inch and a half on each side to allow of more freedom of movement for the legs. It is bent so as to produce a convexity about midway between the site of the disease and the seventh dorsal vertebra, to induce the formation of a compensatory curve in the spine, and again slightly forwards above the shoulders, where a hollowed duralumin plate supports the head, a small pillow, held on by an elastic band, intervening. In high dorsal cases, the frame is bent backwards under the head, instead of forward, and the plate on which the head rests is hollowed sufficiently to allow of hyperextension. Its other features may be conveniently described from the foot upwards. An adjustable felt lined foot rest prevents the feet from dropping, and a bend in the frame at the level of the knees allows the latter to assume their natural position of rest in slight flexion. The lower end of each thigh rests on the wooden crossbar to which the knee straps are attached. The legs lie on a felt covered wooden flap which can be dropped at suitable intervals to allow of active exercise of the thigh and leg muscles, a strap over each knee ensuring that this movement takes place without disturbance of the spine by the psoas. In avoiding the foot rest when raising the legs the child has to dorsiflex his feet, and thus a full range of movement at the ankle joint is maintained and shortening of the tendo Achillis prevented.

A flap beneath the buttocks allows of the use of an enamelled tray, 10 in. by 7 in. by 3 in., as a bedpan, if the frame is on a carriage the tray is suspended from the tubing by a special holder (Fig. 159). This flap, three or four inches wide, is made of duralumin, one border is curled closely round the tubing to serve as a hinge, the free end rests on a flat catch inserted in the tubing, and has a slot through which the catch slips if rotated, thus allowing the flap to drop.

The space between the tubes, where the child lies, is filled with felt, held in position by flannel bandages tightly wound round and covered with crash. Alternately, the child may lie on a crash covered expanded rubber pad (one inch thick, with edges rounded

¹ Reprinted, by permission, from the *Annual Report of the London County Council, 1933* (issued February 1933).

and sealed with rubber solution) which rests on a sheet of duralumin riveted to the under surface of the tubing

The *waistcoat* consists of two transverse pieces of crash towelling connected by a duralumin rod on each side. The chest piece is shaped to accommodate the neck and sends a process over each shoulder, which ends in a webbing loop, at the side it passes beneath the armpit to end in a narrow pocket or hem in which the rod fits. The pelvic piece which ends in similar pockets runs across the lower abdomen, not extending lower than the level of the top of the intergluteal fold, which is the upper limit of the duralu

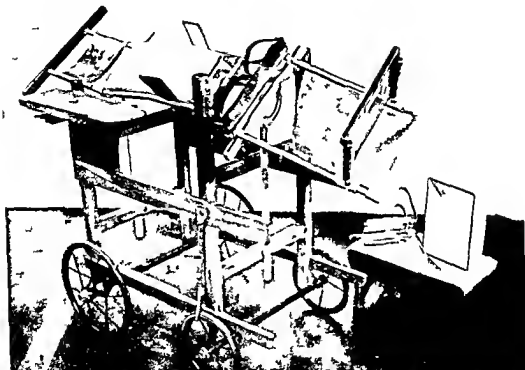


FIG 159 Spinal frame and carriage showing limit of rotation of frame also on the stool the bedpan tray and holder. The length of the carriage can be adjusted to suit the frame

min flap beneath the buttocks. Through slots in the shoulder bar and three holes in each connecting rod the waistcoat is laced behind the frame with blind-cord, the ends of which are tied to a cleat at the foot of the frame out of the patient's reach.

The *carriage* is short, extending only from the shoulders to the knees; it is 30 in. high and consists of four birch uprights joined by side and end rails; it is supported by wheels and bolted to it on each side is a narrow movable arm rest which acts as a table on which the child places his toys, school books or eating utensils. The spinal frame is attached by hooked bolts and winged nuts to two double transverse bars, each arranged to rotate on an upright flat metal bar fixed by screw bolts passing through the wooden end rails of the carriage. A slotted semicircular piece of metal joined to each of these double transverse metal bars and limiting the rotation of the frame to 35 degrees in each direction enables the patient to be placed for a short time every few hours in a position in which the kidney on each side is in turn uppermost (Fig 159). The frame can be adjusted by raising or lowering the metal supports so that the patient tends to slip in neither direction.

The *clothing* consists of vest and nightgown, open along their whole length at the back, and between them a jersey open behind to within 3 in. of the neck. In the winter the legs are enclosed in a bag made of blanket material, a broad binder is wrapped round the pelvis and thighs, and a waistcoat shaped to enclose the shoulders round the chest, both being made of the blanketing and enclosing the frame. A cot sheet, blankets and counterpane complete the bedding. No difficulty has been experienced in keeping patients thus equipped out in the open air on their carriages day and night throughout the winter months. The frame can be readily unclamped from the carriage for transference to a table every four weeks for examination and changing of the coverings.

The hip frame.

In the Annual Report of the Metropolitan Asylums Board for 1926-7, Mr Pugh gave an account of a method of traction in hip disease in which the body weight was employed to overcome the spasm of the muscles joining the trunk and the limb. The rationale was the following: The extent to which traction can be increased is limited by the amount of pull that can be applied for a prolonged period without causing the extension strapping to slip. In weight can extension the effect on the hip joint is reduced by the friction between the affected limb and the mattress. When the method of traction by graduated suspension is adopted on the other hand, the possible effective pull on the joint is increased, and not reduced, by this friction. Thus, together with the constancy of the traction, is doubtless the explanation of the efficiency of the method.

In the simple form first used the apparatus consisted merely of a fracture board, one end of which rested on the bedstead, while to the other was attached a leather strap and buckle to support it when hanging from the bed head rail. A low duralumin rail was fixed to the end of the fracture board and the extension was buckled to this, together with the webbing straps sewn to the mattress to prevent the latter slipping off. External rotation of the affected limb was prevented by a sandal to the sole of which a transverse piece of wood was screwed and the knees were kept slightly flexed by an adjustable wooden bar placed in the appropriate position under the mattress.

In dealing with a patient admitted with an acutely painful hip, he was laid on the mattress, his head towards the foot of the bed, and an extension was applied and tied to the rail of the fracture board. He was allowed to lie in the position he found most comfortable, and gradually during the night the board was raised to the level of the top rail of the bedstead. Usually by morning it would be found that the weight of his body had painlessly reduced the deformity and the limb was in a position of five or ten degrees of abduction with normal lordosis. No special precautions were needed in giving the bed pan, for the continuous and effective traction removed risk of injury to the affected joint, any movement taking place at the lumbar spine, not at the joint. No restraint of the other limb was necessary, but a chest band was advisable to prevent the child from slipping off the bed.

The next development was the substitution for the bedstead and fracture board of a special carriage with an adjustable board on which the mattress rested and which could be raised to a slope of 30 degrees. This enabled the patient to be moved more readily to the courtyard, cricket field and cinema hall, but there still remained the drawback that he was continually in the supine position with its potential risk of stone formation.

The rotating frame. Only during the last year or two has this difficulty been overcome by the introduction of the apparatus now to be described, which allows of suspension traction with the patient in practically a horizontal position and of rotation through about 70 degrees without disturbance of the alignment of the pull on the hip joint.

The gas pipe frame, on which the patient lies, is similar in its general features to the spinal frame already described but is wider at the foot, and is bent at the level of the great trochanter of the affected side towards that side, so that when the pull

produces abduction of the affected limb the vertebrae remain at right angles to the interspinous line. It has small self adjusting wings opposite the pelvis to support the latter when the frame is rotated. The ends of the handlebars are rubber covered, to prevent damage to walls.

A felt covered board, with an adjustable foot piece, supports the *sound limb*. It is hinged to a wooden bar, riveted to the foot of the frame, and its other end is thinned and rests on the knee cross bar. It is divided near the latter end into two pieces, joined by hinges so that it may be lifted and dropped to allow of the sound limb being exercised.

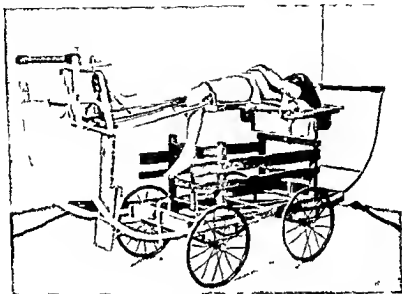


FIG 160 Hip frame carrier and carriage (the sound left limb is being exercised) The carrier is adjustable in length

The distal half of the *affected limb* rests on a felt covered back splint with a fixed foot piece, to which the extension linen strap is buckled on each side. The extension consists of a double layer of stockinette, stuck to the thigh from near the fork to the middle of the patella by means of Böhler's gelatine paste, the wide end of the linen straps are sewn to the distal end of the stockinette cylinder. The back splint rests on a smooth board fixed to the gas pipe frame, and the foot piece is suspended from a pulley wheel resting on a horizontal metal bar attached to the foot of the frame (Fig 160). Screwed to the foot piece of the splint is an iron rod, which is attached to a point near the circumference of a wooden disk or small wheel, the axle of which is fixed to the centre of a transverse flat metal bar (adjustable as to height) forming part of the carriage. This is the device which gets over the difficulty of preserving the alignment of the pull when the frame is rotated.

The frame is supported like the spinal frame on iron uprights with semicircular slots fixed to the wooden carrier, these can be adjusted as to height at either end so that the patient does not slide on the frame. The wooden carrier is of construction similar to the spinal carriage, but its legs rest on ball bearing roller skate wheels which run on an angle iron frame which forms part of the wheeled carriage and the front legs are shorter than the back ones. A transverse iron rod fixed to the middle of the side rails of the carriage, forms an axle on which the angle iron frame can rotate, to allow of the slope of that frame being regulated by a hinged iron attachment which can be fixed at the desired height by means of a bolt passing through the front rail of the

carriage A longitudinal rod, fixed at its ends to the front and back rails of the carriage and passing over the transverse axle of the angle iron frame, is added to ensure that the carrier does not overturn

Each arm rest has fixed to its under surface a wooden block which revolves on a bolt, attached to an iron bar which is screwed to the head end of the carrier The arm rests have to be adjusted according to the position and direction of the bent frame

It will be seen that by these means the affected limb is attached by the extension to the back-splint which is itself attached by the rigid rod and wheel to the foot end

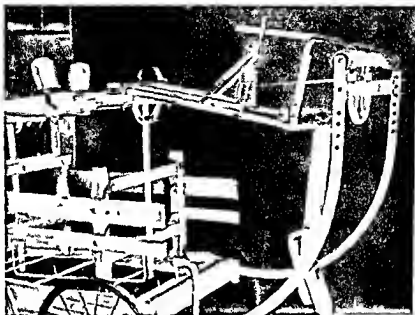


FIG 161 Hip frame and carriage showing details of device for preserving alignment when frame is rotated hook for use while waistcoat is being applied, back-splint with adjustable foot piece for sound limb, &c

of the carriage, while the rest of the patient is fixed to the gas pipe frame resting on the carrier, and that the latter tends to run down hill on the angle iron frame away from the foot end of the carriage the result in effect being extension by suspension When the frame is rotated the rigid rod which is attached to the back splint causes the wheel at the foot end of the carriage to turn (Fig 160) and thus the alignment of the pull on the hip joint is maintained without jarring Every few hours in the day the frame is rotated to the left and to the right, and kept in each position for a quarter of an hour or so so that each kidney in turn is removed from the dependent position without the affected joint being disturbed

SOME STATISTICS OF TUBERCULOSIS OF THE KNEE AT THE SHROPSHIRE ORTHOPAEDIC HOSPITAL

Included by kind permission of R C MURRAY

From 1924 to 1934 inclusive 2 922 cases of bone and joint tuberculosis were treated as in patients in the Shropshire Orthopaedic Hospital and included in this number were 322 cases diagnosed as suffering from tuberculosis of the knee (11 per cent) 124 of these cases were investigated and are summarized in the following tables

	Number	Age of onset (average)	Number proved	Number traced	Average period of observation
1 Synovial	37 (30 %)	1 22 (7)	7 (19 %)	29	9 years
2 Focal articular	78 (63 %)	2-62 (19)	17 (22 %)	64	16 years
3 Extra articular	9 (7 %)	1 8 (3)	3 (33 %)	7	10 years
Total	124	1 62 (14 5)	27 (22 %)	100	13 years

With regard to the number of proved cases it will be observed that the proportion is low. The only proof that has been accepted has been the actual finding of tubercle bacilli or tuberculous tissue under the microscope. The low proportion of positive findings is chiefly due to the fact that material was relatively infrequently sent for examination, the surgeons being usually satisfied with clinical and operative evidence.

Of the 124 cases 100 have been traced either to the present day or to their death and in the last column is shown the average number of years the 100 have been under observation from their onset.

TYPE 1 *Synovial* 29 cases

Period under observation—5-20 years (9)

	Percentage
Full movement	10 (34)
Limited movement (20°-100°)	7 (24)
Unsound ankylosis	4 (14)
Progressed to Type 2	13 (45)
Number excised	6 (20)
Bony ankylosis	5 (17)
Amputation	1 (3 4)
Still active	1 (3 4)
Complications	3 (10)
Died	1 (3 4)

Alteration in length of limb

Lengthening ($\frac{1}{2}$ "-2") 10

Shortening ($\frac{1}{2}$ "-2") 5

The most interesting feature about these figures is the large number (45 per cent) of synovial cases which progressed later to the Focal articular type, the average length of time before focal bone changes appeared being nearly 3 years (1-10).

It is also interesting to note that lengthening of the affected limb was twice as frequent as shortening.

TYPE 2 *Focal articular* 64 cases

Period under observation—5-56 years (16)

	Percentage
Progressed from Type 1	13 (20)
Movable joint	3 (5)
Unsound ankylosis	5 (8)
Bony ankylosis (non operative)	3 (5)
Bony ankylosis (operative)	36 (56)
Non union	1 (1 5)
Still active	4 (6)
Amputation	7 (11)
Complications (tuberculous)	17 (27)
Died	14 (22)

It will be noticed that the period of observation in this group extends to 56 years. This is due to a patient who first attended this hospital during the 1920-34 period, but who had been treated by Hugh Owen Thomas and Robert Jones since 1883.

Thirteen of these cases (20 per cent) judging by their history before admission, had progressed from Type 1, but on admission were definitely Type 2 and are not the same 13 cases featuring in the previous table.

Of the 39 cases treated by excision the youngest was 14 and the oldest 63. No excisions were performed in children in any group below the age of 14. Of these excisions, including 3 re-excisions, but excluding 2 cases that died, 98 per cent resulted in bony ankylosis, there being only one case of non union.

The complications consisted of other tuberculous lesions including phthisis, and in the majority followed the knee lesion and did not precede it. Most of the deaths occurred in these complicated cases.

TYPE 3 *Extra articular* 7 cases

Period under observation—6-18 years (10)

	Percentage
Healed without involving joint	5 (71)
Invaded joint	2 (29)
Died	1 (14)

These figures support the findings of Poncet who in 1929 showed that these lesions on the whole did well. 5 out of 7 healed without involving the joint, 3 having a full range of movement, and 2 about half the normal range. Two only were subjected to operation, and both these now have a full range. One of these, was found at operation to have caseous material in the supra patellar pouch, so that it is hardly correct to say that the joint was not involved. This patient has full movement.

The one death was due to tuberculosis of the spine and bilateral pyonephritis.

From these figures emerge the following facts:

- 1 Tuberculosis occurs in the knee in about 11 per cent of all tuberculous bone and joint lesions.
- 2 Synovial tuberculosis progresses to definite bone changes in 45 per cent of cases.
- 3 There is a high mortality due to other tuberculous lesions in the focal articular type.
- 4 The extra articular lesion on the whole does well.

SOME STATISTICS OF TUBERCULOSIS OF THE SHOULDER AT THE SHROPSHIRE ORTHOPAEDIC HOSPITAL

Included by kind permission of S. M. Thompson

The following is an analysis of the cases of tuberculosis of the shoulder joint which have been treated at the above hospital during the period 1920-34. Of 2,922 cases of bone and joint tuberculosis admitted, the shoulder was affected in 27. 26 cases are investigated—one being untraced.

Of the 27 cases admitted 10 had or had had tuberculosis in other parts of the body.

Hip	3
Elbow	2
Chest	2
Metacarpal	1
Metatarsal	1
Carpus	1

In two of these cases the patient was already an in-patient when the disease was recognized in the shoulder. During the period after admission 3 developed phthisis, one occurred while the patient was already under treatment and proved fatal; the others developed later and in both cases the patient is reported to have recovered.

On admission 12 cases had discharging sinuses, 4 had healed sinuses or healed operation scars, and 8 had no such complication. The presence of a sinus seems to have a most important bearing on the prognosis, as is shown by the accompanying table

Sinuses

	<i>Good</i>	<i>Poor</i>	<i>Died</i>	<i>Not traced</i>	<i>Total</i>	<i>Operation</i>
None	8 (80 %)			2	10	4
Healed	3	1			4	
Discharging	6 (50 %)	1	3	2	12	3
Total	17	2	3	4	26	

Of those who died one was due to septicaemia following excision of the humeral head in a case with a discharging sinus. A second was admitted in a moribund condition with multiple sinuses, she failed to improve and died 5 months after being discharged. The third developed phthisis while in the Hospital and died 3 months later.

The following table summarizes the outlook relative to the radiological appearances

	<i>Total</i>	<i>Good</i>	<i>Poor</i>	<i>Died</i>	<i>Not traced</i>	<i>Proved</i>	<i>Presumed positive</i>	<i>Total</i>
Focal articular	21	12 (57 %)	2	3	4	6	9	15
Extra articular	2	2				1		1
Synovial	3	3					1	1
Total	26	17	2	3	4	7	10	17

Three of the focal articular cases were of the type described as *caries sicca*

OCCUPATIONAL THERAPY, VOCATIONAL TRAINING, RE CONDITIONING, AND REHABILITATION

Many patients admitted to hospital suffering from skeletal tuberculosis will not be able to return to their previous work. They will often stay in hospital a year or more, and it is very much to their advantage that they should during this time prepare themselves for such future employment as is likely to be suitable for them to take up when they leave hospital.

There is thus great need for vocational training as well as occupational therapy. Guided by the medical staff the patients should be encouraged to turn their attention to the future and choose at an early stage some work that will be suited to their character, mental capacity, and physical limitations.

For some patients, probably perhaps a relatively small proportion, there may be direct value in occupational therapy, but for the great majority the time spent in hospital can be used with an immense relative advantage if it is directed towards the preparation for some new occupation.

Occupational therapy in orthopaedic hospitals was advocated, and to some extent practised, in the orthopaedic hospitals of the 1st War. Sir Robert Jones himself and Dr Goldthwait of Boston, when in this country, were ardent advocates of the practice of some handicraft in restoring the activity of wounded limbs. As a result, handicrafts were instituted in the wards and workshops for the convalescents were developed in various orthopaedic hospitals. The work in the wards was beneficial for hands, minds and, incidentally, the pockets of the men. This was genuine, if primitive, occupational therapy. The workshops tended to be used rather for vocational training.

These wartime institutions, based as they were on sound principles, can be applied with equal advantage to the long illnesses of the present day

The choice of occupation is, naturally, a vital matter and calls for a great deal of experience and judgement on the part of an Advisory Officer (see below), who will of course, be informed by the Medical Staff as to the man's physical possibilities and limitations. The Advisory Officer will have to take into consideration not only the man's character, mental capacity, and physical limitations but also the other side of the problem, *this is the opportunities that exist for his employment within easy range of his home, or in some special industry at a distance*

Some patients, then, require occupational therapy, others vocational training, a third group will be able, ultimately, to go back to their previous occupation, provided they can be strengthened by a process of reconditioning. This is best achieved by progressive physical employment designed to re-establish the physical condition of their bodies. *A man must be not only healed but fit and hardened, if he is to undertake a full day's heavy work day after day. Many a man fails to return to his occupation solely because there is no opportunity for what may be termed occupational exercise*

Reconditioning is a process of restoring the strength and tone of the patient. His needs are, of course, both mental and physical. He has to learn to face and to carry through an arduous day's work. Any form of physical exercises which can be carried out under the direction of a masseuse is pitifully inadequate in this respect. Half an hour once or twice a day is, no doubt, a beginning, but there is an immense gap between that and the strain of a full day's work. Regular employment is needed which can be graduated both in the length of time and the physical demands of the work. The patient having advanced quickly up to a point only too often tends to stagnate and thus fails to reach any sort of physical condition. How much happier and better it is for him, mind and body, and for all concerned that he should be given some constructive work graduated within his capacity

Then, again, there are some patients who may not need either vocational training or reconditioning, but require rehabilitation alone, i.e. the finding of some occupation of which they are already capable without special preparation

This, of course, includes the fitting of a person into a wage earning occupation, and covers a very wide field. For the term includes exercise of this function in relation to practically all the patients, whether they have been given vocational training or not

I would suggest that an Advisory Officer (non medical) should be appointed with thorough knowledge of all requirements. The position calls for a man, not only with experience and wide knowledge on the occupational side but one who has a flair for finding employers ready to employ the patients from the hospital who have passed through his hands

The Advisory Officer would be responsible for organizing the whole service with advisory duties in the wards and liaison duties outside

Lovett's Table

Difference in inches between real and apparent shortening	Distance between anterior superior spines in inches																		
	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	11	12	13	
	5°	4°	4°	3°	3°	2°	2°	2°	2°	2°	2°	2°	2°	1°	1°	1°	1°	1°	
	10	8	7	6	5	5	4	4	4	4	4	4	4	3	3	3	3	2	
	14	12	11	10	8	8	7	7	6	6	5	5	5	4	4	4	3	3	
	19	17	14	13	11	10	9	9	8	7	7	7	6	6	6	5	5	4	
	25	21	18	16	14	13	12	11	10	9	9	8	8	7	7	7	6	6	
	30	25	22	19	17	15	14	13	12	12	11	10	10	9	9	8	7	7	
	36	30	26	23	20	18	17	15	14	13	13	12	11	10	10	9	8	8	
	42	35	30	26	23	21	19	18	16	15	14	14	13	12	12	10	10	9	
2½	40	34	30	26	24	21	20	19	17	16	15	14	14	13	12	11	10		
2½		39	34	29	27	24	22	21	19	18	17	16	15	14	13	12	11		
2½			38	32	29	27	25	23	21	20	19	18	17	16	14	13	12		
3			42	35	32	29	27	25	23	22	21	19	18	18	16	14	13		
3½				39	36	32	30	27	26	25	22	21	20	19	17	15	14		
3½					40	35	33	30	28	26	24	23	22	21	19	17	16		
3½						38	35	32	30	28	26	25	23	22	20	18	17		
4							42	38	35	32	30	28	26	25	23	21	19	18	

Kingsley's Table

In	Deg	In	Deg	In	Deg	In	Deg
05	1	65	16	125	31	185	50
10	2	70	17	130	33	190	52
15	3	75	19	135	34	195	54
20	4	80	20	140	36	200	56
25	6	85	21	145	37	205	58
30	7	90	22	150	39	210	60
35	9	95	24	155	40	215	63
40	10	100	25	160	42	220	67
45	11	105	27	165	43	225	70
50	12	110	28	170	45	230	75
55	14	115	29	175	47	235	80
60	15	120	30	180	48	240	90

INDEX

- Abscess, cold, 24, 98
 Acetabulotomy, 81
 Air bath, 17
 Amputation, 27
 —, hip, 93
 —, knee, 167
 —, tarsus, 187
 Aneurysm, 124
 Antiseptic, 25
 Arthritis, acute, of the sacro iliac joint
 175
 —, sub acute and chronic, of the sacro
 iliac joint, 175
 —, gonococcal, 48
 —, with osseous foci, 145
 —, pyaemic, 48
 —, rheumatic, 50
 —, rheumatoid, 50, 215
 —, synovial, of the knee, 144
 —, transient, of the hip, 30
 Arthrodesis ankle, 184
 —, elbow, 210
 —, extra articular, 26
 —, —, shoulder, 202
 —, high, 74
 —, intra articular, 26
 —, —, hip, 26
 —, —, shoulder, 202
 —, low (or ischio femoral synostosis), 77
 —, wrist, 217
 Arthroplasty, 168
 Astragalectomy, 184

Bacillaemia, 1
 Bacilli, tubercle, 2
Bankart, A S B, 81
 Barlow's disease, 48
Beadle, O A, 124
 Bladder, affected by paraplegia, 242
 Blood pressure, 18
 Bovine tubercle bacilli, 2
 Brittan's operation, 72, 77
Buller, R W, 223, 238, 239

Calve, J, 6, 65, 146, 168, 184
 Calve's disease, 103
Campbell, W C, 169
 Carcinoma, 118
 Carshalton extension, 62
 —, frame, hip, 255
 —, —, spinal, 253
 Cerebrospinal fluid, protein of, 240
 Clutton's joints, 140
Codman, F A, 193

 Complications 7
 Costotransversectomy, 244
 Coxa vara adolescent, 43 46, 47

 Decubitus prolonged, 17
 Deformity correction of, 29
 —, —, — hip, 50, 84
 Diagnosis, 9
 —, laboratory, 10, 13
 —, provisional 11
 —, secondary, 21
 Diagnostic operation, 12, 13, 70
 —, radiography, 11
 —, tuberculin tests, 12
 Diet 15
 Disk hernia, 124
 Dissemination, risk of 20
 Drainage, operation of hip, 89

Elmslie, R C, 167
 End results hip 94, 95
 — knee, 143
 — sacro iliac, 181
 —, shoulder, 204
 —, spine 139, 140 141 142, 143
 Epiphyseodesis, 29
 Examination clinical, 9, 10, 33, 34, 35, 103
 Excision of knee, indications for, 162
 Extra articular arthrodesis, 26
 —, —, hip, 71
 —, —, shoulder, 202
 —, foci, 7, 26, 160

Fairbank, H A T, 168
 Fish tail graft operation for spine, 132
Frame, Carshalton, 253
Francis, Robert Jones, 251
Fraser, Prof Sir John, 145
Freyberg, A H, 168

Gardner, A D, 13, 14
Galland, M, 65
Gauvain, cannula, 178
Gauvain, Sir H, 24
Griffith, A S, 1.

 Haemophilia, 48
 Hebotherapy, 15, 17.
Henderson, M S, 166
 Hernia of the intervertebral disk, 124
Hibbs, R A, 98
Hill, L, 16
 Human tubercle bacilli, 2
Hysteria, 54

Ilio diaphyseal graft (Berck), 75
Incubation, period of, 4
Infection, pyogenic, 88
—, secondary, 25
Injury, 4
Ischio femoral synostosis, 77

Jones, Sir Robt, 15, 21, 33, 163, 168

Key L A, 18
Kidneys, 17, 18
Kingsley's table, 262
Kummell's disease, 123
Kyphos pads, 126
Kyphosis, adolescent, 108

Lambrinudi, C, 108
Lardaceous disease, 8, 15
Lesion, skeletal, 3
—, localization of, 5
Liebolt, F L, 213
Lovett R H, 61
Lovett's table, 262
Lowenstein, E, 7
Lumbago, 124
Lumbo-sacral graft operation, 132

Mantoux test, 10, 36
March fracture, 192
Measurements, 34
Medico legal, 4
Meningitis, 8
Mennell, J, 180
Murray, R C, 207

Neoplasms, 53, 119
Nursing, of paraplegia, 241

Ober, F R, 12
Occupational therapy, 260
Operation, acetabulotomy, 81
—, amputation, 27
—, —, hip, 93
—, —, knee, 167
—, —, tarsus, 187
—, arthrodesis, ankle, 184
—, —, elbow, 210
—, —, extra articular, 26
—, —, —, hip, 71
—, —, —, shoulder, 202
—, —, thigh, 74
—, —, intra articular, 26
—, —, —, hip, 71
—, —, —, shoulder, 202
—, —, low, 77
—, —, wrist, 217
—, arthroplasty, 168
—, astraglectomy, 184
—, Brittain's, 72, 77
—, costotransversectomy, 244

Operation, diagnostic, 12, 13, 70
—, drainage, of hip, 89
—, epiphysiodesis, 29
—, ilio diaphyseal graft (Berck), 75
—, ischio femoral synostosis, 77
—, knee, of, 159
—, laminectomy, 246
—, lumbo sacral graft, 132
—, paraplegia, for, 242
—, pseudarthrosis, 27, 28
—, —, hip, 81, 94
—, shoulder, of, 202
—, spine, fish tail graft for, 132
—, —, fusion, of, 130
—, —, H' graft for, 131
—, —, laminectomy of, 246
—, —, lumbo sacral graft for, 132
Osgood, R B, 12
Osseous disease of the wrist, 213
Osteitis deformans (Paget's disease), 125
—, periarticular, 50
Osteoarthritis, elbow, 207
—, hip, 41, 50
—, knee, 156
—, sacro iliac, 176
—, shoulder, 197
—, spine, 116
Osteochondritis, 39, 192
—, dissecans, 43, 209
—, spinal, 105
Osteoclastoma, 196
Osteogenesis, 26, 69
Osteomyelitis, 33

Paget's disease (Osteitis deformans), 125
Paraplegia, nursing of, 241
—, operation for, 242
Perthes' disease, 41, 43, 103
Pemister, D B, 29
Plaster bed, preparation of, 252
Platt, H, 39
Pott, Percival, 231
Prophylaxis, 2
Pseudarthrosis, 27, 28, 81, 94
Pseudocoxalgia, 39, 40
Pugh, W T G, 253
Pyogenic disease of the spine, 116

Queckenstedt's test, 226, 234

Radiography, 11, 36, 103
Renal calculus, 17
Rheumatoid spondylitis, 113
Richard, A, 75
Robert Jones's frames, 251.
Roller's table, 16

Sacro iliac strain, 177
Scheuermann's disease, 106
Schmorl's disease, 106

- Scoliosis, 109, 226
Seddon, H. J., 13, 113, 149, 213, 231, 232, 240
 Sepsis, prevention of, 25
 —, treatment of, 25
 Splintage, 20
 —, ankle, 182, 186
 —, hip, 56, 69
 —, knee, 158, 159, 164
 —, shoulder, 198.
 —, spine, 135
 Spondylitis, ankylosa, 115
 —, rhizomelique, hip, 52
 —, —, sacro iliac joint, 176
 —, —, spine, 115.
 —, rheumatoid, 113
 Spondylolisthesis, 119
Sundt, H., 10
 Synovial disease of the wrist, 213, 217
 Syphilis, elbow, 208.
 Syphilis, hip, 37, 45
 —, shoulder, 196.
Thomas, H. O., 20, 21, 22, 34
Thompson, S. M., 259
 Trumble's operation, 74, 77
 Tubercle bacilli, types of 2
 Tuberculin tests, 10, 36
 Turning case, 126, 128
 — —, preparation of, 253
 Verrall graft, 174, 179
 Vitamins, 15
 Vocational training, 260
Waldenstrom, H., 29, 98
Wassermann test, 36, 45
Watson Jones technique, 202
Wilson, J. G., 74
Wilson, P. D., 43